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THE EFFECT OF ONSET RATE ON AIRCRAFT NOISE ANNOYANCE

VOLUME 2: RENTED HOME EXPERIMENT

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WYLE RESEARCH
WYLE LABORATORIES
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13. ABSTRACT *(Maximum 200 words)*
This report presents the results of the second in a proposed sequence of studies to investigate human annoyance to noise from low-altitude military training route (MTR) flight operations. The sequence ranges from laboratory studies, in which the physical and social parameters are well controlled, but highly artificial, to field attitudinal surveys, in which these parameters are largely uncontrolled, but the setting is natural. In this second study, participants were exposed to recordings of MTR noise events in a rented home, in which the social setting and presentation of sound stimuli were more normal than in the previous laboratory experiments.

In the laboratory study, it was found that MTR sounds having onset rates faster than 30 dB/second caused annoyance beyond what would be expected from the corresponding sound exposure level (SEL). The best fit to the data was found to be an onset rate adjustment to SEL, which has the form of a linear relation on a dB versus log (rate) scale, from dB at a rate of 30 dB/second to 11 dB at 150 dB/second. The rented home study confirmed the laboratory onset rate adjustment, although the adjustment was found to begin at 15 dB/second rather than at 30 dB/second.

In addition to re-examining the onset rate adjustment, the study also addressed the effect of the infrequency of occurrence and the irregularity of the stimuli on human reactions.

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1.0 EXECUTIVE SUMMARY

This report presents the results of the second in a series of studies to investigate human annoyance to noise from low-altitude military training flight operations. The noise environment associated with such operations is characterized by infrequent, irregular, sudden, short, loud noise events. The normally accepted relation between annoyance and sound level[1,2] was developed by Schultz from social studies of human response to noise from civilian air, rail, and highway transportation noise sources. Individual noise events from such sources are generally more frequent, more regular, less sudden, of longer duration, and less loud than individual noise events from low-level flight operations. Thus it cannot be assumed *a priori* that the Schultz curve accurately predicts annoyance to noise from such operations.

The purpose of the series of studies, then, is to determine whether or not current methods of annoyance assessment are applicable to noise from low-level training operations. The results of these studies will provide the Air Force with better methodologies for determining and defending their position in the environmental impact analyses that are required to modify existing training procedures.

Preliminary assessments of the noise environment under military training routes[3,4] suggested that, in addition to the sound levels of the events, their high onset rate and infrequent, irregular occurrence may also play a major role in determining human annoyance. To account for the estimated effect of onset rate, an interim acoustic metric, L_{dnmr} (onset rate corrected, busiest month, day-night average sound level), was recommended to describe the average noise exposure from low-altitude military training flight operations.[5] The L_{dnmr} metric was subsequently adopted by the Air Force for use in assessing community noise impact from military training routes.[6] The fact that onset rate contributes annoyance that adds to the annoyance produced by the acoustic level of the flyover has been further confirmed by independent Air Force experiments.[7]

The L_{dnmr} metric adds onset rate adjustments to the individual aircraft overflight sound exposure levels (SELs) that are used to compute the busiest month, day-night average sound level (L_{dnm}). Apart from the addition of this adjustment, the L_{dnmr} is computed in the same manner as is L_{dnm}. The recommended onset rate adjustment, which varies from 0 decibels (dB) for onset rates below 15 dB/second to 5 dB at onset rates above 30 dB/second, is shown in Figure 1(a).

Reference 3 recommended a continuum of psycho-/socio-acoustic studies to more accurately assess human annoyance to noise from low-altitude military training flight operations. These range from laboratory studies, in which the physical and social parameters are well controlled, but highly artificial, to field attitudinal surveys, in which these parameters are largely uncontrolled, but the setting is natural. Table 1, which has evolved through the course of the studies since the publication of Reference 3, lists the first three recommended studies along that continuum.

Table 1

Sequence of Studies to Validate Correction Procedures

Study	Sound Stimuli	Average Exposure Rate	Exposure Time	No. of Subjects
Laboratory	Artificial	30/hr	2 x 2 hr	80
Rented Home	Artificial	3/hr	2 x 6 hr	60
Hybrid Own Home	Artificial and Real	≈8/day	1 month	30

The laboratory study has recently been completed.[8] In addition to confirming the appropriateness of the onset rate adjustment, this study refined the form of the adjustment to 0 dB for onset rates below 30 dB/second to 11 dB for onset rates above 150 dB/second, as shown in Figure 1(b).

This report presents the results of the "rented home" experiment, in which the social setting and presentation of sound stimuli were more normal than in the laboratory experiments. In addition to re-examining the onset rate adjustment, the study also addressed the effect of the infrequency of occurrence and the irregularity of the stimuli on human reaction.

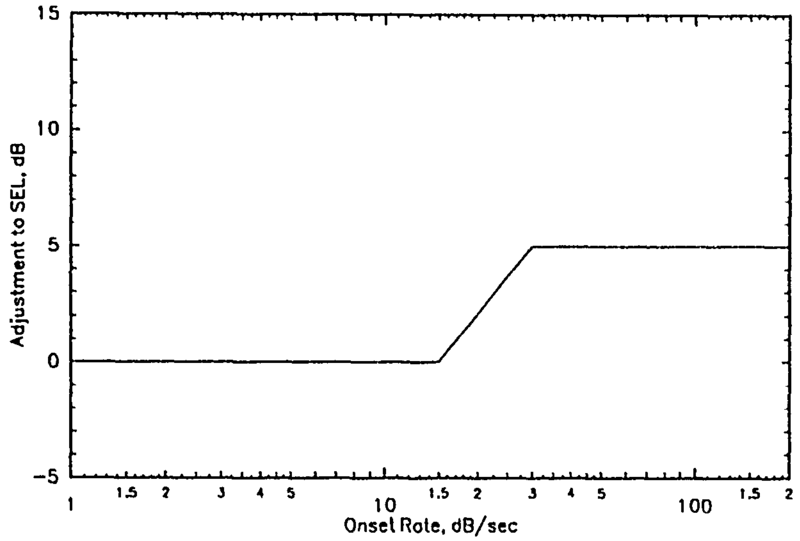


Figure 1(a). Onset Rate Adjustment in Interim Metric [5,6]

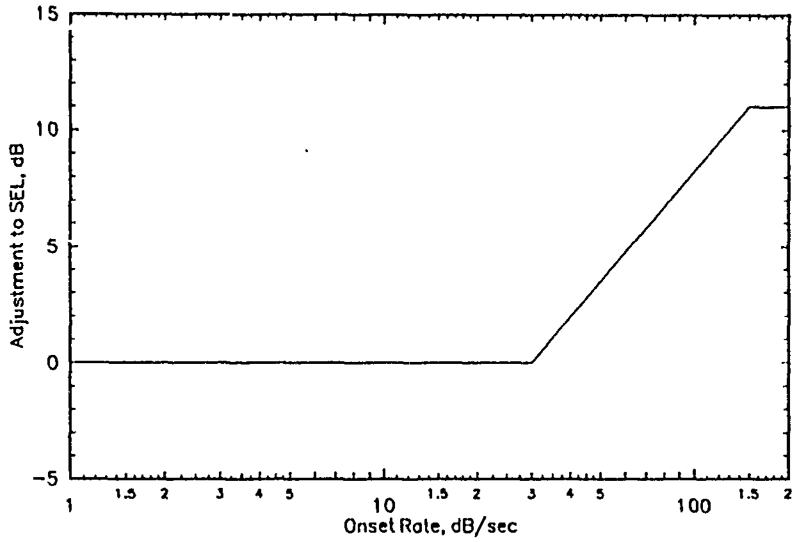


Figure 1(b). Onset Rate Adjustment From Laboratory Experiment.[8]

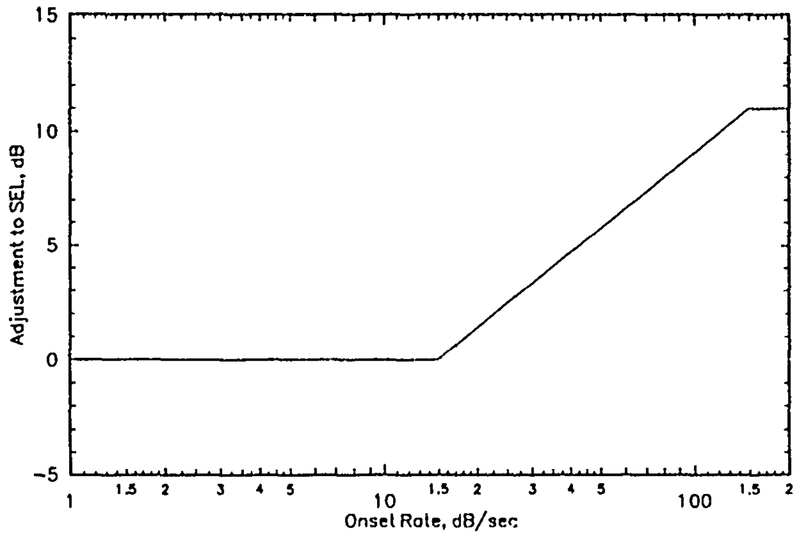


Figure 1(c). Onset Rate Adjustment From Rented Home Experiment.

The results of the rented home study again confirm the appropriateness of the onset rate adjustment. As shown in Figure 1(c), the format of the adjustment is almost the same as that found in the laboratory study, i.e., 0 dB for onset rates below 15 dB/second to 11 dB for onset rates above 150 dB/second. Only the onset rate at which the adjustment first becomes non-zero differs between the two experiments.

The appropriateness of the use of the onset rate adjustment developed in the laboratory and rented home studies is further confirmed by the fact that the relation between the participants' hourly responses and the onset-rate corrected hourly equivalent sound level developed here more closely matches the Schultz curve[1,2] than does the relation between the participants' hourly responses and the uncorrected hourly equivalent sound level, or the relation between the participants' hourly responses and the onset-rate-corrected hourly equivalent sound level defined by the present interim metric.[5,6]

In addition, there is a preliminary indication that, when compared to the effects of sound level and onset rate, there is no statistically significant additional effect of the number of sound stimuli per hour on the average hourly responses of the participants. Thus any effects on annoyance of the infrequency of occurrence of the noise events appears to be second-order. The responses to a post-test questionnaire generally confirm these quantitative results.

Completion of the rented home study is an important step along the laboratory-to-field-study progression described above. However, in both this study and the laboratory study, the social setting and the presentation of sound stimuli were, of necessity, more artificial than that which occurs in the real world. The question of whether or not the onset rate effect remains important when the participant is involved in normal household activities and when there are even fewer events per day is still largely unanswered.

Section 2 of this report provides a more detailed introduction to the rented home study than is given in this executive summary. Sections 3 and 4 provide, respectively, details of the experimental design and experimental procedures employed in the study. Section 5 provides the results of the study.

Appendices A through D provide details of the data that was collected in the rented home study.

2.0 INTRODUCTION

2.1 Background

An accurate understanding of human response to noise from low-altitude flight operations in military operating areas (MOAs) and along military training routes (MTRs) has long been of interest to the U.S. Air Force because of the need to prepare environmental assessments during the design of these airspaces.

Conventional methods of assessing human annoyance to noise, such as that developed by Schultz,[1,2] are based on studies carried out on the human response to highway, railroad, and commercial aircraft noise sources. These assessment techniques use as an acoustic metric the day-night average sound level, L_{dn}, which averages the sound energy from the individual noise events over a 24-hour period, with a 10 dB penalty for noise occurring between 2200 and 0700 hours.

The noise environment associated with low-flying military flight operations is very different than that investigated by Schultz, being characterized by infrequent, irregular, sudden, short, loud noise events. Thus the L_{dn} for such operations is often quite low and, as a result, conventional assessment techniques predict little or no resultant annoyance. However, complaints about low-flying flight operations are not uncommon.

To better understand human response to such operations, a preliminary assessment[3] of the noise environment under MTRs was carried out in 1985. This analysis suggested that major factors affecting human annoyance to such a noise environment included the high amplitude and short duration of the noise from individual overflights, Doppler shifts associated with high speeds, the relatively few number of overflights per day, and the unpredictable occurrence of these overflights.

In 1986, initial field studies were conducted along an MTR used by B-1, B-52, and FB-111 aircraft.[4] The speed at which the aircraft approached, and the resultant high onset rate of noise, were prominent effects. This high onset rate led to the most commonly reported observations by residents that they were often annoyed because they were surprised by the aircraft. High levels, brief durations, and sporadic occurrences of the noise events were also quite evident.

Based on the results of these studies, a review was made of the available literature to investigate the suitability of correlating L_{dn} with human annoyance for sporadic, high onset rate noise events.[5] This review suggested that:

- the use of L_{dn} is valid even for one or two events per day, although an "average busy day" concept should be used in defining the appropriate L_{dn}, and
- an onset rate adjustment should be applied to L_{dn} to account for potential increased annoyance to sudden noise events.

Two recommendations resulted from this review:

- the L_{dn} for MTRs should be based on the busiest month of the year, thus providing an L_{dnm}, and
- an onset rate adjustment should be applied to the individual sound exposure levels (SELs) used in computing L_{dn}, to provide an onset rate-adjusted sound exposure level, SEL_r.

The result is an onset rate-adjusted, busiest month, average day-night sound level, L_{dnmr}.

In 1990 an interim L_{dnmr} metric (see Figure 1(a)) was adopted by the Air Force for use in assessing community noise impact from military training routes.[5,6] However, it was recognized that, while L_{dnmr} was based on the best available data, much of the support for its use is circumstantial.[5]

Since independent studies conducted by the Air Force have confirmed that onset rate contributes additional annoyance beyond that produced by the acoustic level of the flyover,[7] work has continued on validating the use of the L_{dnmr} metric.

2.2 Proposed Sequence of Experiments

Reference 1 recommended a continuum of psycho-/socio-acoustic studies to more accurately assess human annoyance to noise from low-altitude military training flight operations. This continuum starts with laboratory studies, in which the physical and social parameters are completely controlled and in which, of practical necessity, the average exposure rate is much higher and the total exposure time is much lower than normally occurs.

The recommended continuum progresses through a series of studies which, at each stage, become less artificial in the sense that the average exposure rate continues to decrease, the exposure time continues to increase, and the associated social activities become more realistic. The final stage is a social survey, in which residents living under MTRs complete a series of questionnaires over a long-term period.

Table 1 in Section 1 lists the major recommended studies along that continuum. The list here differs somewhat from that originally presented in Reference 3 by the addition of a "hybrid own-home" study. This additional study is necessary to fill the large gap in average exposure rate and exposure time between the "rented-home" study and the "own-home" study.

In this sequence of studies, the sound stimuli for the laboratory and rented home studies are artificial, in the form of tape-recorded military jet plane overflights. For the own-home study and the social survey the sound stimuli are actual overflights. The hybrid own-home study uses a combination of artificial and real stimuli to obtain the desired average exposure rate.

The average exposure rate ranges from 30 events per hour in the laboratory to an estimated 2 events per day in the real world. The exposure times range from 2 periods of 2 hours each in the laboratory to a continuous 12-month period for the social survey.

The social activities which the participants undertake range from a single defined activity in the laboratory study, to several defined activities in the "rented-home" study, ending with multiple, undefined natural activities in the social survey.

Finally, the environment in which the participants experience the sound stimuli ranges from the artificial, foreign setting of a laboratory, to a normal, but unfamiliar, home setting in the rented home study, ending with the normal, familiar setting of the participant's own home in the hybrid own-home study, the own-home study, and the social survey.

2.3 Summary of Results of the Laboratory Experiments

The laboratory experiments were completed in 1991 and have been reported on in Reference 8. The following conclusions were reached in that study:

- Onset rate has a genuine effect on human annoyance.
- Decay rate and/or duration may have independent effects on annoyance; however, for typical MTR sounds, they are sufficiently correlated with onset rate that onset rate may be taken to be the single significant parameter.
- An SEL_T, which embodies the currently defined onset rate adjustment of 0 dB below 15 dB/sec and 5 dB above 30 dB/sec, with a $\log_{10}$(onset rate) transition between, is a better predictor of annoyance than is SEL alone.

Other onset rate adjustments were found which better correlated with reported annoyance than the interim metric. The best fit to the data was an adjustment of 0 dB below 30 dB/sec and 11 dB above 150 dB/sec, with a $\log_{10}$ (onset rate) transition between.

The interim metric onset rate adjustment to SEL[5,6] and the best-fit adjustment for the laboratory experiments[8] are shown in Figures 1(a) and 1(b), respectively, in Section 1.

2.4 Overview of the Rented Home Experiment

The purpose of the rented home experiment, which is reported here, was to confirm the existence of and quantify the onset rate effect under more realistic conditions than those in the laboratory experiments and, in addition, to begin to investigate the effects of the infrequency of occurrence and the irregularity of the noise events on human annoyance.

In the study, 60 participants were exposed, in groups of six, to a series of tape-recorded sound stimuli presented during two 6-hour periods on separate days. The participants were recruited from a pool of participants who were familiar with low-flying military aircraft sounds. The study was conducted in a rented ranch-style home which was typical of the surrounding area.

During presentation of the sounds, participants viewed video movies, read magazines, and assembled jigsaw puzzles in rooms inside the house and played board games on the deck outside the house. Television and magazines were single-person activities; puzzles and board games were two-person activities At the end of each one-hour session, the participants changed activity so that, throughout each six-hour period each participant took part in each activity.

At the beginning of each day, the sound exposure levels of the stimuli presented within the house were adjusted to 95 dB; those outside the house were adjusted to 110 dB. Levels were continually monitored at the participants positions throughout the testing period.

Participants noted their annoyance to each stimulus on a prepared form which used the same nine-point scale as was used in the laboratory studies. In addition, at the end of each one-hour session, participants noted their response to the sounds within that session on the same scale. From one to five stimuli were presented in each one-hour session. At the end of the two-day test period, participants noted their overall response to all of the aircraft sounds which were presented on the nine-point scale.

3.0 EXPERIMENTAL DESIGN

3.1 Objectives

As noted in Section 2, the objectives of the rented home study are twofold:

- To confirm the existence of the onset rate effect under more realistic conditions than those in the laboratory experiments; and

- To investigate the effects of the infrequency of occurrence and the irregularity of the noise events on human annoyance.

To accomplish these goals, a setting more similar to a normal home than the settings used in the previous laboratory study was required. This setting should be located in a rural area since, by design, most MTRs are located in sparsely populated regions of the country. In addition, a nearby population of non-naive participants (i.e., persons who had previously experienced the noise from MTR activities) was needed.

Because the rate of exposure to aircraft sounds that was desired in this study (see Table 1 in Section 1) is much higher than normally occurs in MTRs, it was not possible to use actual aircraft overflights as the stimuli. Thus the test facility had to have the capability of being instrumented to provide playback of tape-recorded stimuli.

An examination of the DoD Area Planning AP/1B Chart of Military Training Routes in the mid-eastern United States revealed the intersection of six MTRs – three Air Force, two Navy, and one Air National Guard – in Mecklenburg County in southern Virginia. A reconnaissance of this region revealed a large population who had experienced noise from low-flying military aircraft.

With the assistance of a local realtor, a suitable furnished rental home, which could be instrumented as desired, was located in Bracey, Virginia.

3.2 Rented Home

The rented home was a three-bedroom, two-bath ranch house with a living room, den, dining room, kitchen, and attached garage. It had a wrap-around rear porch that opened onto a large backyard that led to a lake. Figure 2(a) is a photograph of the front of the house; Figure 2(b) is a photograph of the rear porch. Figure 3 shows the floor plan of the house.

The house was selected because it was typical of many of the residences in this portion of rural Mecklenburg County. This part of the county is composed of a predominantly recreational and retirement community centered around Lake Gaston. The rest of the county consists mainly of farming and light industry. Given the large recreational lake, one small city, and several towns, the typical house in the county was a residential property like the one selected. Furthermore, the ranch-type house employed in the present study was quite typical of the average American single-family residence.

The house was fully furnished by the owner and was in move-in condition. Minor redecoration was required to adapt certain rooms for use during the experiment. Nevertheless, the interior retained its natural local character and provided a typical and familiar residential setting for the participants in the experiment.

The house was located on a quiet road sufficiently far away from nearby neighbors to ensure relative freedom from exterior noise intrusions. The most frequent environmental noises were from occasional cars on the road. The noise from low-flying military aircraft on MTR operations was heard about twice a week. The presence of actual MTR flyovers added to the realism of the environment. The participants were instructed, however, not to pay attention to or to formally rate the annoyance from these MTR flybys.

3.3 Sounds

3.3.1 Sound Selection

The six recorded aircraft sounds used in the rented home experiment were a subset of those used in the laboratory experiments. The production of these

Figure 2(a). Photograph of Front of Rented Home.

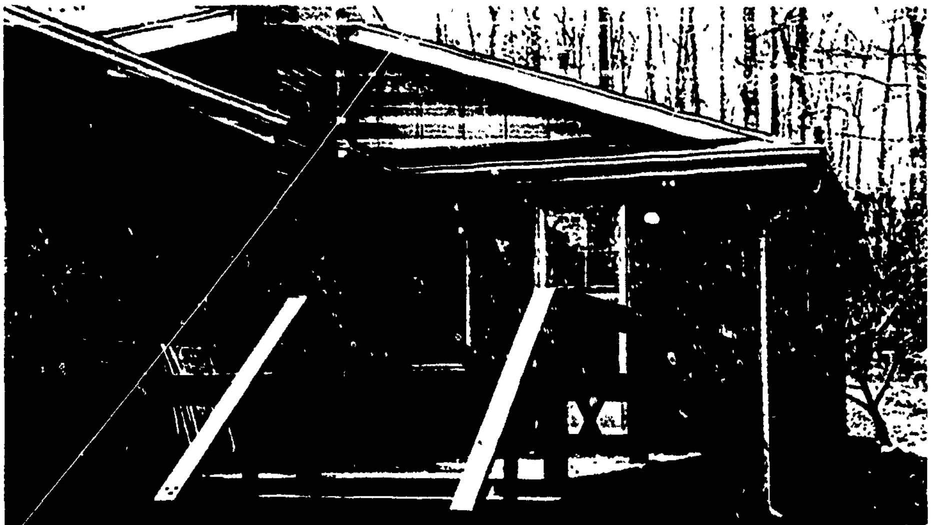


Figure 2(b). Photograph of Rear Porch of Rented Home.

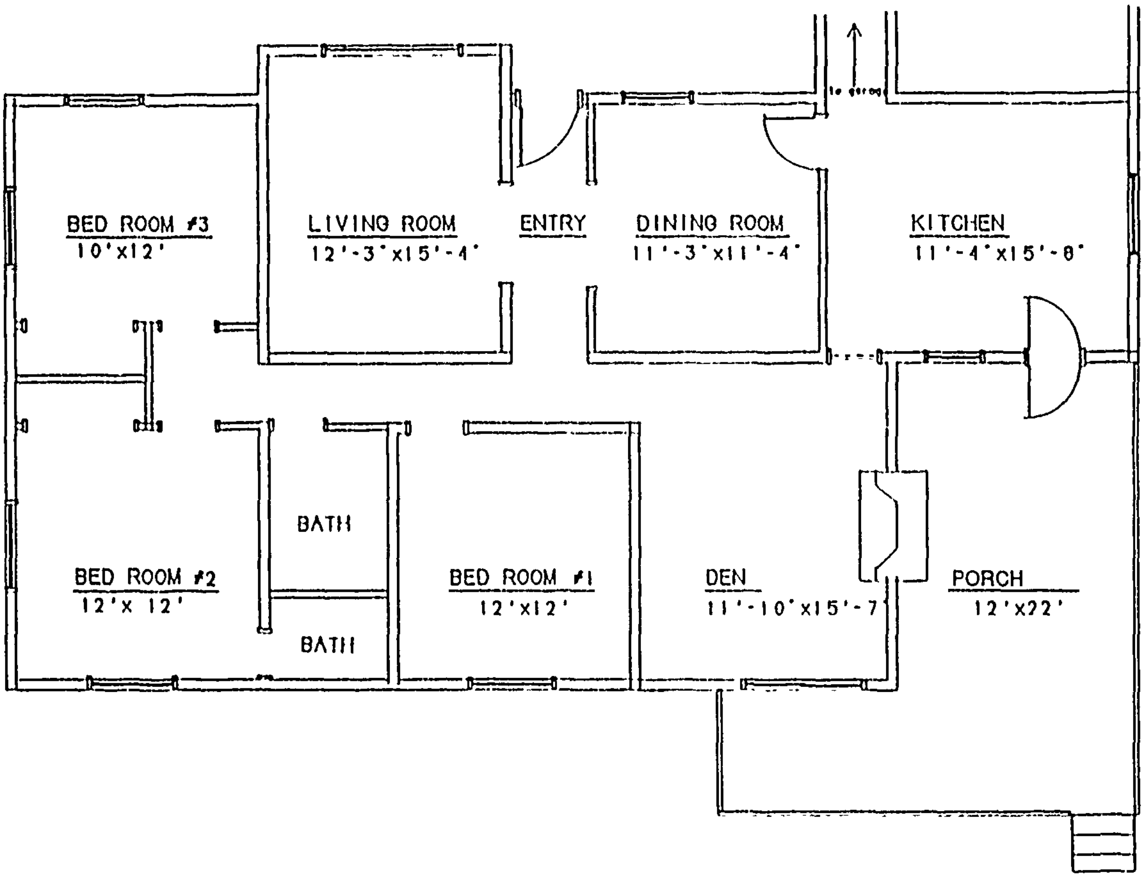


Figure 3. Floor Plan of Rented Home.

recordings is described in detail in Reference 8. The recordings were modifications of recordings of military aircraft overflights made by the Air Force in 1988.

The aircraft, test conditions, and acoustical properties as reported with the original data are summarized in Table 2. The aircraft identification includes the aircraft name and a designation of the relative speed of the aircraft during the test.

The properties of the re-recordings, as modified by the procedures described in Reference 8, are shown in Table 3, which summarizes the onset and decay rates, duration, and difference between L_{max} and SEL for the six actual sounds. Two durations are shown. One is the time between 10 dB down points. The other is the total duration of the recording, from initial fade in to final fade out. Two L_{max} - SEL values are shown, corresponding to slow L_{max} and fast L_{max}.

Note that some of the quantities in Table 3 differ from those in Table 2. This occurred for two reasons. First, cleaning up the sounds and adjusting durations changed some properties. Second, a slightly different method for obtaining onset rate was used. The original rates, given in Table 2, were obtained by an algorithm employing the highest 20 dB of digitized levels. The digitization analysis system included a fast (0.125 second) detector for all sounds. The rates shown in Table 3 were based on measurements of slopes on a level recorder chart, using a wider range than just the highest 20 dB. When determining the slopes, the paper speed and writing speed of the level recorder were adjusted so that the measured slopes represented the signal and not the time constant of the detector.

As discussed in Reference 8, the re-recording process introduced a stereophonic effect so that the sounds had directional qualities. As presented to the participants, the sounds were perceived to come from front-to-back or from back-to-front, as discussed below.

3.3.2 Session Tapes

Presentation of sounds was carried out in a sequence of one-hour sessions. The sounds for each session were copied onto a single digital audio tape, with sounds in the desired sequence and separated by inter-stimulus intervals of from 5 to 40 minutes. The following procedure was used:

Table 2

Aircraft Noise Recordings Used as Source of Experimental Stimuli

Aircraft	Altitude (Feet)	Lateral Offset (Feet)	Speed (Knots)	SEL (dB)	L_{Amax} (dB)	Onset Rate (dB/sec)
FB-111, Med.	1,028	2	521	107.5	107.9	17.3
FB-111, Fast	228	70	524	118.1	121.8	53.9
B-1B, Slow	2,130	2,021	355	83.4	76.6	2.7
B-1B, Fast	217	70	586	117.3	121.1	59.8
F-4D, Med.	1,000	1	550	111.1	111.1	22.4
F-4D, Fast	108	54	597	122.9	128.0	108.9

Table 3

Properties of Actual Sounds, as Employed in Rented Home Experiments

Sound	Onset Rate (dB/sec)	Decay Rate (dB/sec)	10 dB-Down Duration (sec)	Total Duration (sec)	L_{max} – SEL (Slow)	L_{max} – SEL (Fast)
FB-111 Med.	16	5.0	8	41	-3.5	1
FB-111 Fast	42	15	2.3	37	-1.5	4.5
B-1B Slow	1.9	1.1	14.3	75	-7	-6.5
B-1B Fast	68	27	0.5	31	-1	5
F-4D Med.	22	7	2.4	66	-4	1.5
F-4D Fast	152	49	0.3	49	-1	6

- Twelve lists of sound stimuli along with inter-stimulus intervals were randomly generated, with the constraints that specific sound stimuli and inter-stimulus intervals were uniformly distributed over each of the two experiment days, and that 18 sounds would occur on each day.

- A list of directions, for sound stimuli on each tape, was randomly generated. These were used to vary perceived direction during the sessions.

- Stimuli were digitally copied from the master tape to each session tape, separated by the inter-stimulus intervals, according to the generated lists.

Twelve session tapes were prepared for the experiment; this ensured that no participant heard the same tape more than once.

3.3.3 Sound System Design

Figure 4 shows the sound system configuration used. Stereo signals of the six digitally mastered recordings were generated by a digital audio tape deck. The signals were directed to a manual switch box, which was used to reverse the perceived direction and then input to a dual distribution amplifier where two independent, 1 in by 4 out, circuit groups served to amplify and direct the stereo signals to four separate outputs. Each of the four stereo outputs was then equalized, amplified by a power amplifier, and directed to one of four pairs of loudspeakers.

Signals generated from the sound system were equalized, at each microphone position, using two-third octave band equalizers. A 2 dB per octave rolloff was used indoors to represent the typical filtering effect of a house. Outdoor stimuli were presented through a system which had been equalized for flat response, to preserve the sound quality of the original outdoor recordings.

The sound system was calibrated to produce an average SEL of 110 dB outdoors and 95 dB indoors, over the six experimental stimuli. The outdoor levels are consistent with measured values along actual MTRs. Indoor stimuli were produced at levels 15 dB lower, to represent the typical attenuation of a house. The sound system operated at a set gain throughout the entire experiment.

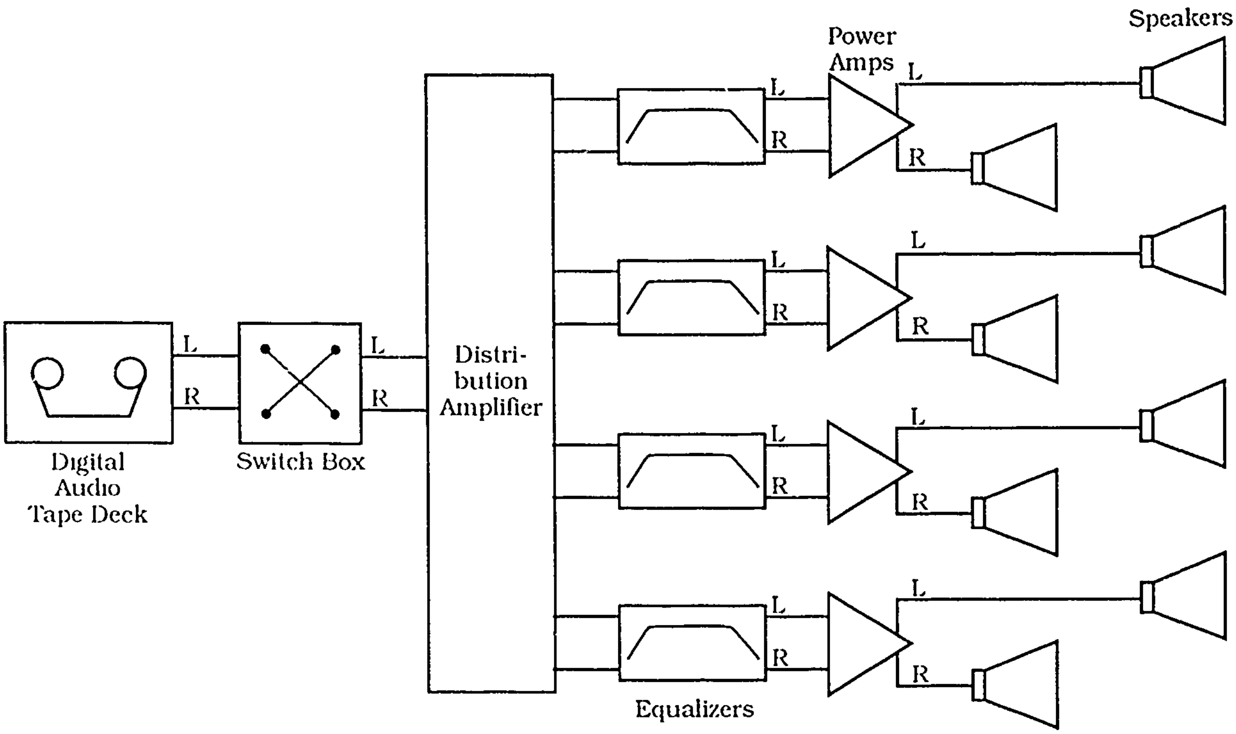


Figure 4. Sound Reinforcement System at Rented Home.

3.4 Facilities

Testing at the rented home was carried out in three indoor rooms and on the rear porch. Figures 5 through 8 show key features at each test location. The solid dots indicate the positions at which each of the six participants were seated. The identification number for each position is shown in a circle near each dot. The circled Xs show the locations of the monitoring microphones.

In the indoor rooms, pairs of loudspeakers were arranged diagonally in each room. On the porch, the two loudspeakers were positioned along its length.

Each test location contained one or two seating positions. The seating positions in the den and the reading room were located halfway between the loudspeakers in these rooms. The seating positions in the dining room and on the porch were arranged such that the midpoint between the participants, who were facing each other, was also the midpoint between the loudspeakers, at these locations.

Sound level meters were used to monitor the actual levels heard by the participants. Microphones were mounted near the participant(s), at each test location (see Figures 5 to 8).

A two-way intercom system was used to communicate with the participants. This system consisted of a master unit which was controlled by the experimenter, and four satellite units, one near each of the participants.

Electric floor fans were positioned in each room to create a background noise level of approximately 50 dB at each microphone position. The direction of airflow was away from the participants at indoor locations (the house was air conditioned) and toward the participants on the porch. This background noise helped to mask residual noise occurring at the beginning and end of some of the recordings.

3.5 Activities

It was important that the participants in the present experiment be engaged in realistic and meaningful activities during the listening sessions in the rented home. These activities would discourage direct attention to the aircraft

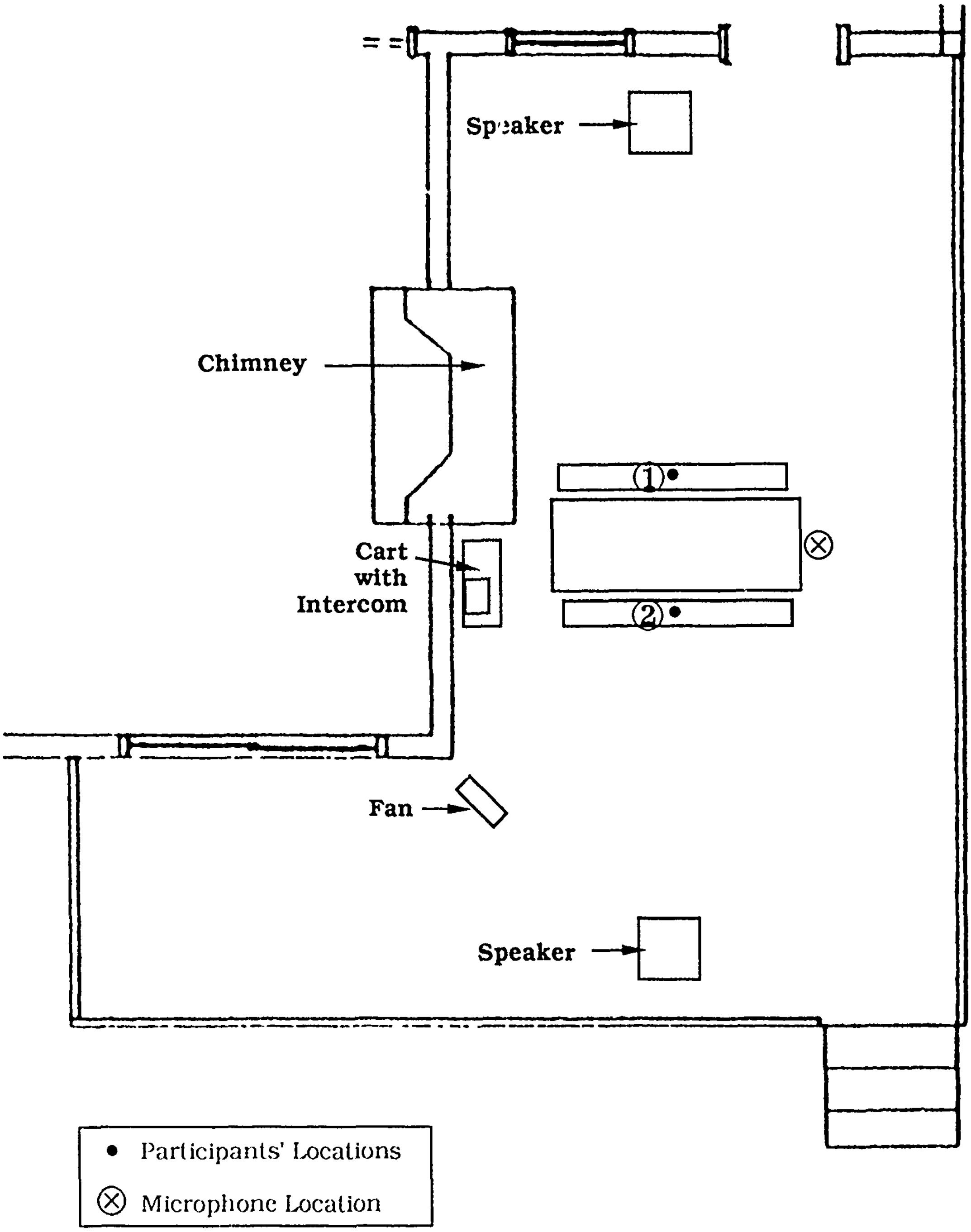


Figure 5. Porch.

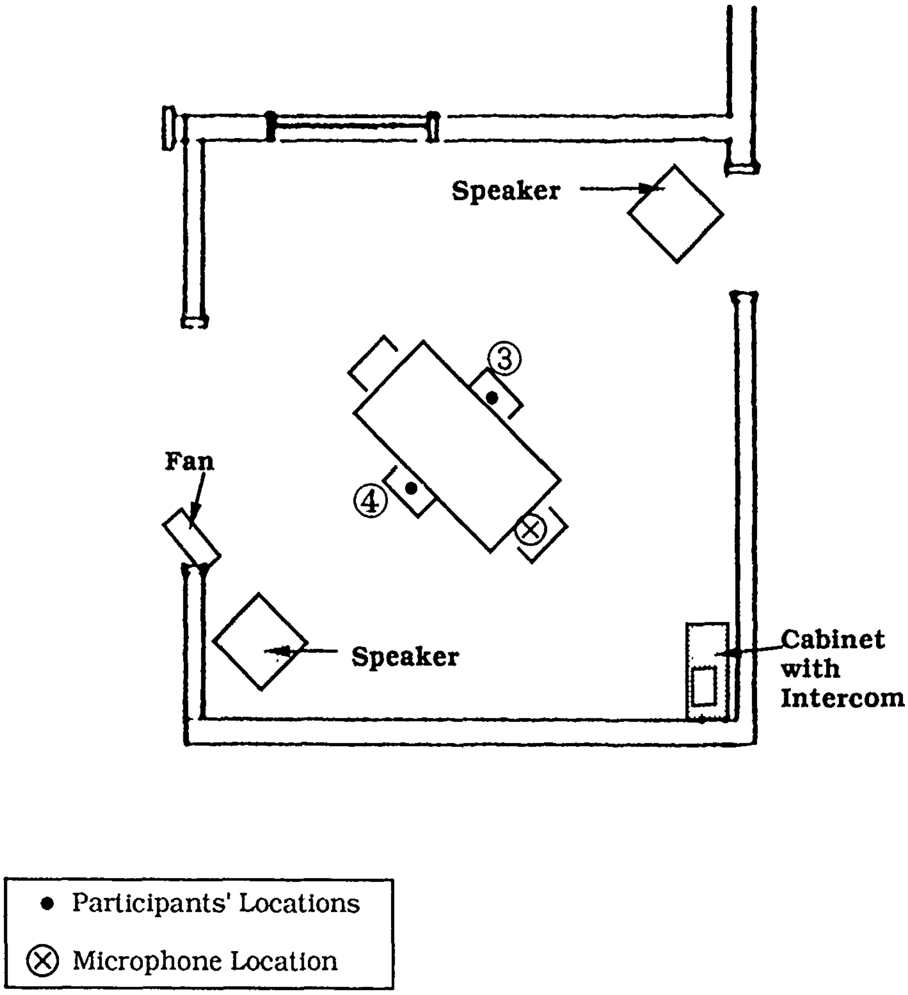
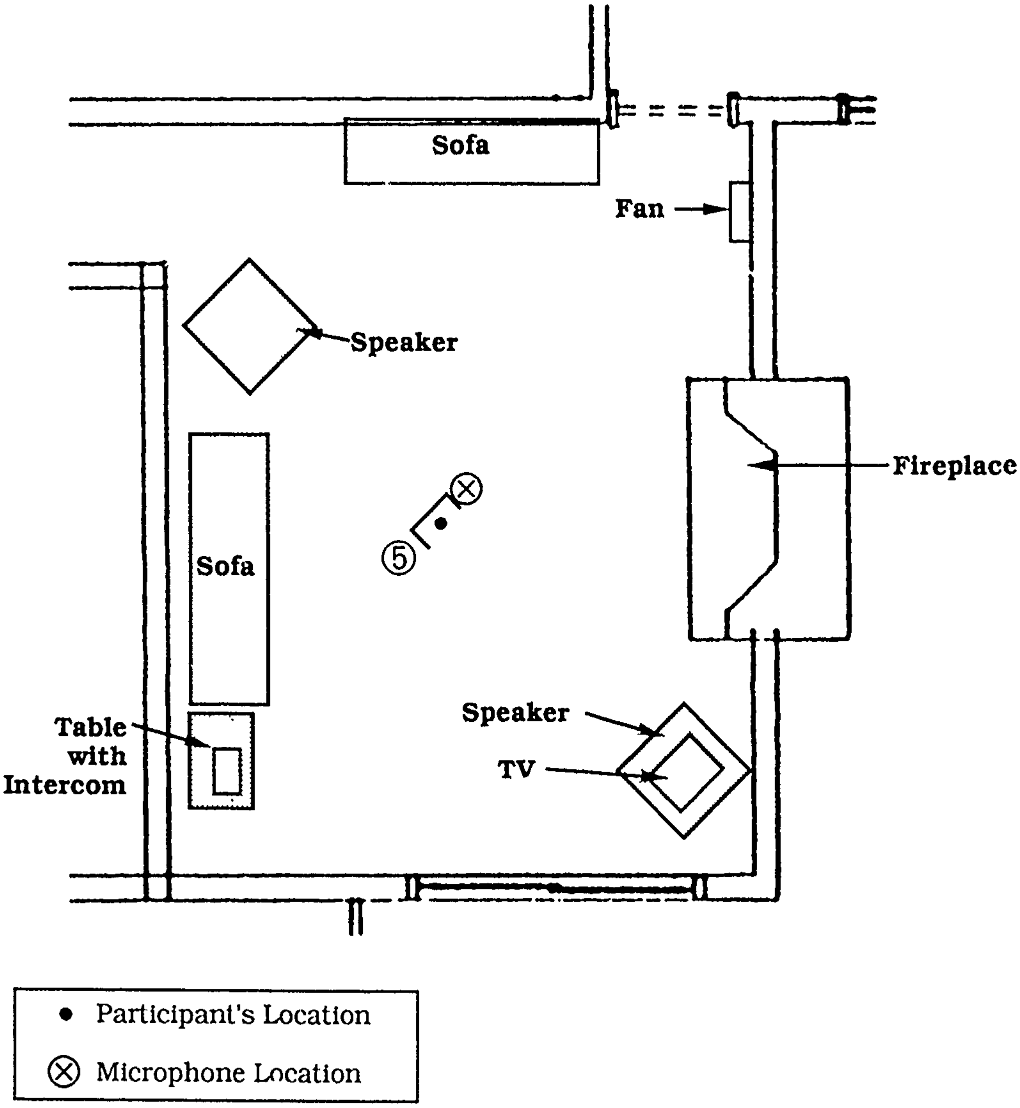


Figure 6. Dining Room.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Participant's Location
Microphone Location

Figure 7. Den.

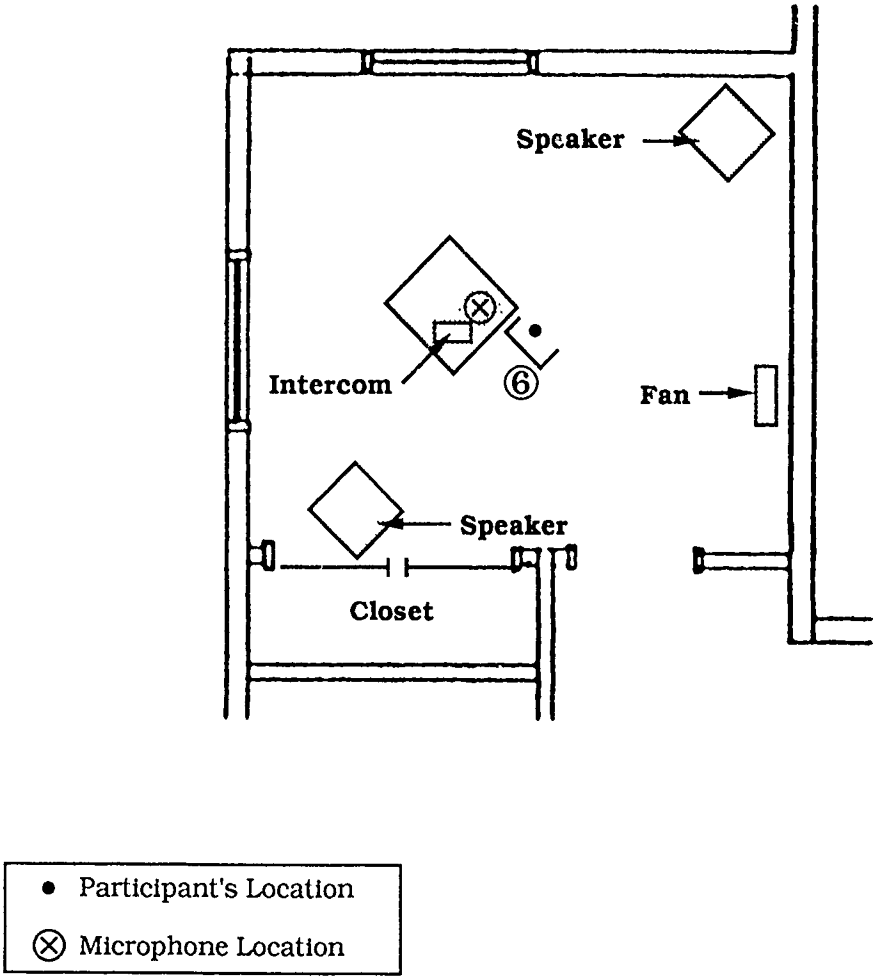

Figure 8. Bedroom #3 Configured as a Reading Room.

flyby stimuli themselves, thereby reducing the "stimulus fixation" effect sometimes observed in laboratory psychoacoustic experiments.

The activities selected included both social and individual pastimes. The social activities consisted of playing board games or putting together jigsaw puzzles. The individual activities consisted of viewing video movies or reading magazines.

While playing board games, two participants were seated opposite each other at a picnic table outdoors on the porch. While putting together puzzles, two participants were seated opposite each other at a dining table in the dining room. The Annoyance Rating Response forms, on which participants recorded their responses to sounds, were kept covered for the social activities in order to prevent participants from seeing and thus possibly influencing each other's ratings.

The viewing of video movies took place in the den, where a single participant sat in a chair facing the television set. The reading activity took place in one of the bedrooms, which had been redecorated as a reading room. Here a single participant sat in a chair with a rack of magazines at the side. Lists of the puzzles, games, video movies, and magazines employed in the experiment may be found in Table 4.

Activities were chosen on the basis of several criteria. First, the activities should represent realistic, leisure time behaviors that might be observed in a typical home. Second, some of the activities should be social in nature, affording opportunities for limited interaction among participants during a listening session. At the same time, other activities should be individual in nature, where a single participant is alone in a particular room of the house during a listening session. Third, the activities should be performed from a single seated position for the entire duration of the listening session so that the participant remains in a well-defined acoustic field. This criterion excluded certain realistic but mobile household activities such as cleaning, cooking, or doing the laundry.

Table 4(a)

Puzzles Used for Task Activity

Bambi	Mountain Scene
Cactus	Sea Shore
Country Farm	Stock Car

Table 4(b)

Games Used for Task Activity

Scrabble	Battleship
Yahtzee	Pachisi
Chinese Checkers	Checkers
Uno	Cards

Table 4(c)

Videos Used for Task Activity

Steel Magnolias	House Party
Field of Dreams	Bird on a Wire
Taking Care of Business	Problem Child

Table 4(d)

Magazines Used for Task Activity

Motor Trend, June 1991	*Good Housekeeping*, June 1991
Country Living, June 1991	*Redbook*, June 1991
Hunting, June 1991	*Women's Day*, May 1991
Muscle & Fitness, June 1991	*Outdoor Life*, May 1991
People, May 1991	*Newsweek*, May 1991
Family Circle, June 1991	*Time*, May 1991
Hot Rod, May 1991	*Better Homes & Gardens*, May 1991
Baseball, 1991	*Glamour*, June 1991
Bass, July 1991	*Cosmopolitan*, May 1991
First, May 1991	

Care was taken to ensure that all of the activities would be interesting to the participants. Informal surveys were conducted when purchasing activity items (i.e., games, puzzles, movies, and magazines) in order to select activities that would be appealing to the local population. Additional items were purchased based on feedback and suggestions given by participants during a pilot test. All activity items were purchased locally. During previous experiments in the current research program only one type of activity was performed and no social interaction was allowed. The goal of the present study was to provide the participants with a variety of more realistic activities and to permit limited social interaction in an attempt to further enhance simulation fidelity and to increase the generalizability of the data obtained.

3.6 Annoyance Response Scale

For consistency with the previous study, the nine-point scale used in the laboratory experiments[8] was used to rate annoyance response. Seven of the nine points on the scale were provided with a verbal descriptor; the extreme points on the scale were unlabeled. Thus the rating instruction was as follows:

THE SOUND WAS:

0	1	2	3	4	5	6	7	8
	Minimally	Slightly	Fairly	Moderately	Decidedly	Highly	Extremely	

ANNOYING.

The rationale for the use of this scale is discussed in Reference 8.

4.0 EXPERIMENTAL PROCEDURES

4.1 Participants

Participants were recruited from Mecklenburg County, Virginia, by means of newspaper advertisements. Participants were required to be at least 18 years old, live in the Mecklenburg County area for at least one year, hear military jet overflights around their house or at work at least a few times a month, and have normal hearing (±20 dB of ISO threshold). Altogether, 72 people were given hearing tests in order to obtain 60 qualified participants.

The resultant sample of participants had lived in the area anywhere from one to 60 years, with a mean residence of 13.5 years. For the most part they lived in Bracey (19), La Crosse (14), and South Hill (13). The participants ranged in age from 18 to 65 years, with an average age of 34 years. The age range of the participant sample was similar to that of the earlier laboratory experiments.[8]

Only 16 of the participants in the current study were male, while 44 were female. The previous laboratory experiment had employed an equal number of males and females and a similar ratio was hoped for in this study. However, it proved difficult to obtain a more balanced sample of males and females in the present study for two reasons. First, the majority of younger and middle-aged males in the community had regular full-time jobs during the day. They could not participate since they would miss two days of work. Consequently, many of the participants were female homemakers. Second, most of the people who failed the hearing tests were male (9 out of 12). Since the laboratory experiment had shown no dependence of response on the sex of the respondent, it was decided that this male/female ratio was acceptable.

The most prevalent occupations of the participants were homemaker (16), laborer (11), professional (9), student (8), and clerical (7).

Participants reported hearing between two and 210 military jet overflights per month at home (mean of 21) and between zero and 210 military jet overflights per month at work (mean of 17). These distributions were highly skewed toward higher counts by a single individual. Without that individual's data, the highest number of overflights per month was 90 at home and 28 at work.

With the single extreme value excluded, the estimated mean number of overflights at home was 18 per week, with a distribution as shown in Figure 9. As is evident in the figure, the modal category of responding was between 1 and 10 overflights per week. These latter estimates conform to general experience of an average of 1 to 2 overflights per day on a typical busy MTR.

4.2 Procedures

4.2.1 Hearing Test

Prospective participants who answered the newspaper advertisement were first screened by telephone. If they met the initial criteria for participation, they were scheduled for a hearing test. A Teledyne Avionics Autometric Audiometer Model TA-20 was employed to administer these hearing tests. Normal hearing was defined to be within 20 dB of the age-corrected ISO absolute hearing threshold at the audiometric test frequencies of 1000, 2000, 4000, and 6000 Hz. People who failed the hearing test were given $10.00 for their time. People who passed the hearing test filled out an Informed Consent form and were immediately given a training session.

4.2.2 Training Session

The training session took place in the den and lasted approximately 20 minutes. First, the participant filled out an Experiment Registration Form and read an Introduction which explained the activities and listed various rules. Next, the experimenter explained how to fill out the Annoyance Rating Response form.

The participant was then given a brief practice session containing all six of the recorded MTR sounds to be used in the experiment. These six sounds are listed in Table 5 in the order in which they were presented during training. During this session, the participant watched a video-taped program that was used only for the training session.

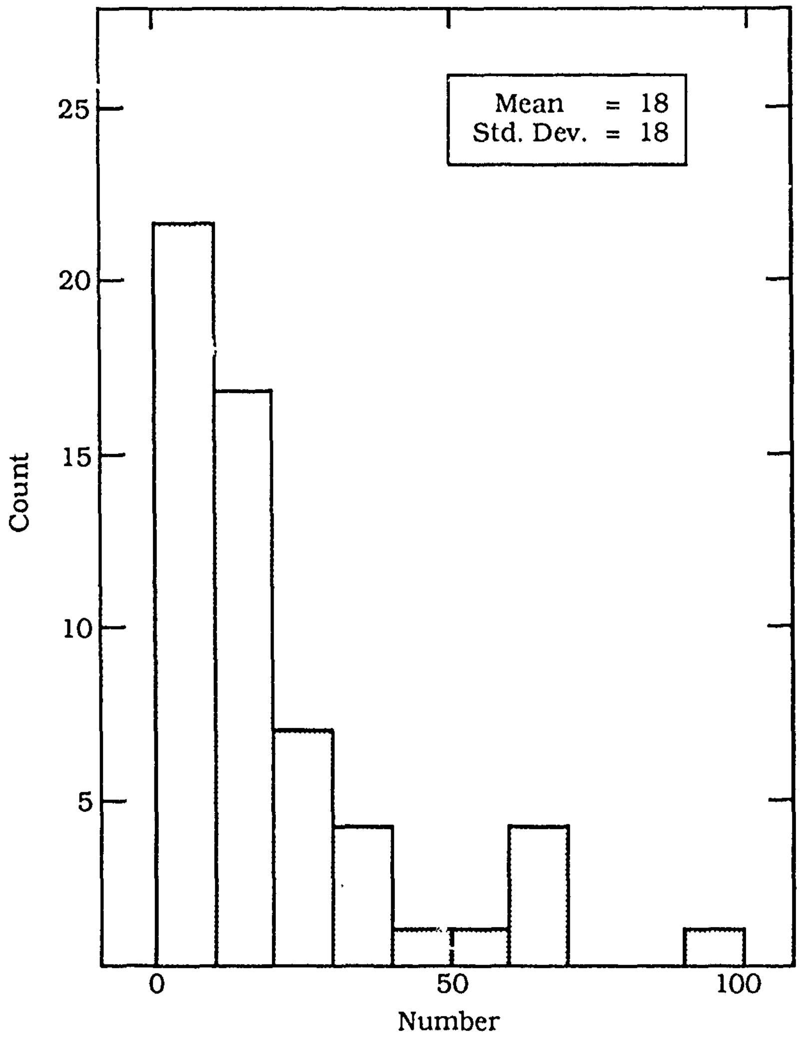

Figure 9. Distribution of Estimated Number of Flyovers Per Week Heard at Home (59 Respondents).

Table 5

Training Session Stimuli

Sound	Design SEL (dB)	Approach Direction
FB-111A, Medium	95	Front
B1-B, Fast	95	Front
F-4D, Medium	95	Back
B1-B, Slow	95	Front
F-4D, Fast	95	Back
FB-111A, Fast	95	Front

This practice session was designed to acquaint the participants with the types and range of recorded MTR sounds that they would hear during the experiment, and to give them experience with using the Annoyance Rating Response form. The experimenter notified the participant of the end of the session and reviewed the response form for errors. The participant was then scheduled for the main experiment and paid $10.00 for the training session.

4.2.3 Overall Schedule

A total of 60 people, in ten groups of six, participated in the experiment. The experiment lasted two days for each group. The second day was essentially a repeat of the first day with different schedules of sounds and different sequences of activities.

Each day consisted of six one-hour listening sessions. During the first hour of the day, each participant was assigned to one of the six seats shown in Figures 5 to 8 in Section 3. At the end of a listening session, all participants would change seats so that, in a given day, each participant would have occupied each seat once.

Thus, during each of the two days, each participant would have carried out each social activity twice (occupying a different seat each time) and each individual activity once.

The twelve audio tapes containing the recorded MTR overflight sounds were randomly ordered for each participant group with the constraint that the total number of sounds for a given day had to equal 18. This was done so that order effects, temporal patterns, and repeated rhythms could be avoided, while keeping the number of events presented each day equal. Each audio tape lasted one hour and delivered anywhere from one to five recorded MTR overflight events. The sounds were separated by Inter-Stimulus Intervals (ISIs) of from 5 minutes to 40 minutes, with a mean separation of 20 minutes between recorded overflights.

During a given one-hour session the participants rated the annoyance of each individual overflight sound immediately after it occurred on the Annoyance Rating Response form. At the end of the hour, the participants rated the overall annoyance of all the overflight sounds heard during that one-hour session. The former was called the individual sound annoyance rating; the latter was called the session annoyance rating. A third annoyance rating embraced all the recorded MTR overflight sounds heard during the entire experiment. It was called the experiment annoyance rating and was given as part of the Post-Experiment Questionnaire.

The number of occurrences and the time of occurrence of a recorded MTR sound was quite unpredictable in any given listening session. On the average, three recorded MTR overflights were heard each hour. Of course, some hours contained only one recorded flyby sound. Furthermore, this one flyby sound could occur at any time during the hour session: early, in the middle, or late. Such a relatively sparse and sporadic stimulus presentation schedule was purposely devised to enhance the simulation fidelity of the experiment. Whereas during the previous laboratory experiments recorded aircraft flyby sounds were heard about once every two minutes on the average, during the present experiment recorded MTR sounds were heard about once every 20 minutes on the average.

On a busy route, actual MTR overflights may be heard on the average as often as twice a day during daylight hours, or once every 360 minutes. Thus the stimulus presentation rate in the present simulation experiment was somewhere between the frequent stimulus rate of the laboratory study and a possible realistic overflight rate at which actual MTR sounds might be heard in the environment. The current study presented sounds about 10 times less often than the laboratory experiments, but still about 20 times more often than might be encountered in real life. The average number of real overflights over their homes estimated by the participants of the present study was about 2 per day.

4.2.4 First Day Schedule

On the first day, the participants were greeted and given an oral review of information highlights from the Introduction and training session. Next, the participants took a tour of the house, during which they received specific instructions concerning the activities they were to perform. After the greeting and the tour, participants were assigned to one of the six seats located either in the house or on the porch.

Seating assignments were made using a pseudo-random process. Six patterns of seating assignments for use on any given day were devised according to the following criteria. First, each participant had to occupy each seat once each day. Second, no participant took part in the same activity twice in a row on the same day. Third, as much as possible, games and puzzles were not played with the same person twice. This last criterion was violated one time each day for both the puzzle and game activities. However, pairs of participants who were repeated on the first day were not repeated on the second day.

Participants were randomly assigned to seats for the first session of a day, but assignments for the remaining sessions followed one of the six previously devised patterns. Each pattern was used three or four times. The two patterns used for a given group were selected randomly with two constraints. First, no groups should have the same pair of seating patterns. This condition was violated once, but the order of the patterns was reversed. Second, no pattern should be used exclusively on the first or the second day.

At the beginning of each listening session, the experimenter checked to see that all participants were in their assigned seats and had correctly filled out the headings on their Annoyance Rating Response forms. The participant in the den was checked last so that the experimenter could start the video cassette player and then immediately start the audio tape for that session and announce over the intercom system that the session had begun. This announcement signaled the participants to begin their activities.

Similarly, an announcement was made at the end of the session to signal the participants to stop their activities and to prepare the activity items for the next participant(s). During this time the experimenter collected the data sheets and reviewed them to ensure that they were filled out properly. Participants were permitted a 15-minute break between sessions. They were allowed to rest only in designated areas of the house not being used for the experiment.

After each session, new seating assignments were given and the procedure described above was repeated. A one-hour lunch break was given after the third session of the day. At the end of session six, the participants were paid $50.00 for completing the first day of the experiment.

4.2.5 Second Day Schedule

The procedure for the second day was similar to that for the first, except that no introduction and tour were necessary. This time the sessions were numbered from seven to twelve rather than one to six. Lunch came between sessions nine and ten. At the end of session twelve the participants were given a short break and then received a final hearing test. For each participant, the results from this final hearing test were compared with the results from the initial hearing test in order to ensure that no hearing loss had occurred during the time of the study. The participants also filled out a Post-Experiment Questionnaire while waiting for their hearing test. Finally, the participants were thanked and paid $140.00 for completing the second day. Each participant received a total of $200.00 for taking part in the study - $10.00 for the initial hearing test and training session, $50.00 for the first day's participation, and $140.00 for the second day's participation.

4.3 Sound System Operation

As described in Section 3.3.2, stimuli for each session were pre-recorded on a session tape. Each session tape was utilized in a unique predetermined order for each group. The order ensured that no participant heard the same session tape more than once, and that exactly 18 sound events were produced each day, for each combination of session tapes. A session tape played continuously during each one-hour session.

Announcements were made over the intercom system to notify the participants of the beginning and end of each session. As a safety precaution, the intercom system was also used to monitor the participants and to allow them to notify the experimenter of any emergencies.

Once a session was in progress, a manual switch was operated to reverse the stereo signal channels generated by the DAT recorder. This provided control over the perceived direction of motion for each sound event. The experimenter followed a list, made for each experiment tape, which included: sound stimuli, inter-stimulus intervals, and the particular direction associated with each sound event.

Independent measurements were made of the sounds actually heard by the participants during each session. Larson-Davis Model 700 sound level meters were used to measure and store data for each sound event. Measurements were obtained, at each location, at the microphone position shown in Figures 5 through 8 in Section 3.

A three-step calibration routine was practiced at each test location, prior to each day of experimentation.

- Sound level meters were checked for calibration.
- The level of the background noise source was measured at the microphone position.
- A tape recording of calibrated pink noise was played through the sound system and measured at the microphone position. This served to check the sound system gain as well as the individual output of each loudspeaker.

The levels of the sound stimuli measured during the experiment provided a final check on the sound system output. The result of each calibration test was entered into a log, which was maintained to track the performance of particular equipment components throughout the experiment.

Sound levels of experimental stimuli were generally produced to within ±1 dB of the design goal at all indoor locations, and ±2 dB at the outdoor location. No system gain adjustments were necessary, after the final calibration.

The variations in day-to-day levels at the outdoor test location appeared to be determined by local weather conditions. The levels produced by the outdoor loudspeakers fell somewhat short of the design goal on days with high relative humidity. Sound-to-sound variations of A-weighted indoor levels are due to the 2 dB per octave filtering. Table 6 shows, in order of onset rate, the measured SEL of each experimental sound at each indoor and outdoor location, averaged over the entire experiment.

The noise monitoring systems remained in calibration to within ±1 dB over the duration of the experiment. Noise levels produced by the background noise source, at each location, were consistent throughout the experiment.

Table 6

Average Measured SEL (in dB) for Experiment Sounds

Sound No.	Aircraft	Onset Rate (dB/sec)	Porch	Dining Room	Den	Reading Room
1	B-1B, Slow	1.9	111.2	95.1	98.0	99.0
2	FB-111A, Med.	16	109.9	94.8	94.6	95.0
3	F-4D, Med.	22	109.7	94.5	94.3	94.9
4	FB-111A, Fast	42	108.9	95.0	94.4	94.9
5	B-1B, Fast	68	108.1	94.9	94.8	95.4
6	F-4D, Fast	152	106.1	95.0	93.8	94.4
	Overall Average	---	109.0	94.9	95.0	95.6

4.4 Data Qualification and Processing

Throughout the experiment, data were collected, reviewed, and entered into a computerized data base.

As response sheets were collected after each session, an experimenter would review each sheet, checking that participant information was complete and that response scores in the proper range had been noted for each stimulus presented. Any inconsistencies were resolved by interviewing the respondent.

At the end of each day, sound event level data were collected from the sound level meters at each test location. After examining the data for consistency, the levels were adjusted to account for the difference in level between the average participant's ear location and the microphone position, at each test location. This adjusted sound level is the level actually heard by each participant for each stimulus presentation.

In addition to participant response scores and adjusted acoustic data, the data base included: event number, sound type, direction, activity, seat, session, group, day, date, and the sound properties specific to each aircraft. The complete data file contains 2,880 records (2,160 sound ratings and 720 session ratings). Each record contains data pertinent to each participant rating, throughout the experiment.

A two-step review process was conducted to qualify the data base. Sorts on each column of data were performed to group similar data, making it easy to spot data entry errors. In the second part of the review process, randomly selected records from the data base were thoroughly reviewed and compared with raw data. Five percent of the data base was reviewed in this fashion.

5.0 RESULTS

This discussion of the results of the rented home experiment first analyzes the responses to the individual aircraft sounds and then analyzes the responses to each one-hour session.

The analysis of individual aircraft sounds addresses the relation between response and onset rate and setting/level (i.e., an outdoor setting with sound levels having a nominal SEL of 110 dB or an indoor setting with sound levels having a nominal SEL of 95 dB). It concludes with a recommendation for the best onset rate adjustment for correcting the SEL of individual overflights.

The analysis of one-hour sessions addresses the relation between response and the frequency of occurrence of noise events, as measured by the number of events per hour.

5.1 Response to Individual Aircraft Sounds

5.1.1 Summary of Response Data

Figure 10 summarizes the responses to each of the individual aircraft sounds. The solid symbols show the distributions of the annoyance ratings for the Indoors/95 dB and for the Outdoors/110 dB presentations. The open symbols in this figure show the distributions of annoyance ratings for the corresponding laboratory studies - Indoors (K1 experiment) and Outdoors (K2 experiment).[8]

As was the case of the laboratory experiments, the present data shows no indication that the participants ran out of room at either end of the annoyance rating scale.

The laboratory distributions are much broader than the corresponding rented home distributions because each of the former represent a range of sound levels while each of the latter represent only a single sound level. That is, the Indoors (K1) laboratory experiment included nominal sound levels of 65, 75, 85, and 95 dB, while the Indoors/95 dB rented home experiment was conducted at a nominal sound level of 95 dB. Similarly, the Outdoors (K2) laboratory experiment

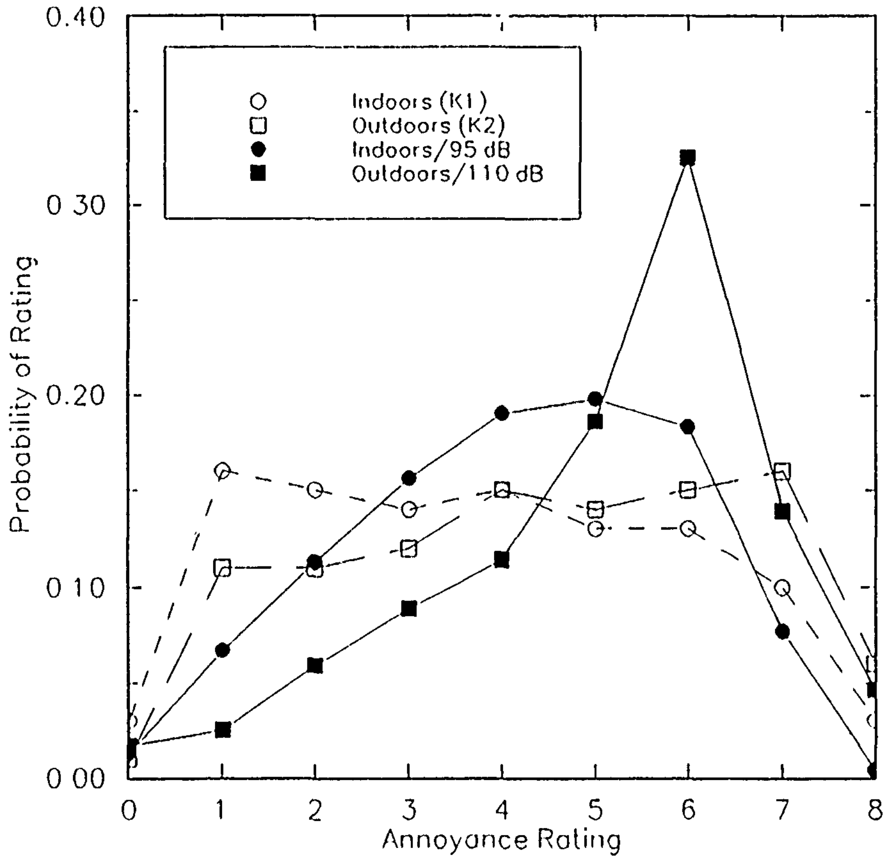

Figure 10. Distribution of Annoyance Ratings.

included nominal sound levels of 80, 90, 100, and 110 dB, while the Outdoors/ 110 dB rented home experiment was conducted at a nominal sound level of 110 dB.

5.1.2 Analysis of Variance

Table 7 is the analysis of variance (ANOVA) of the individual response data. This is a two-way analysis with the main variables of setting/level and onset rate. As indicated in the last column, in all cases, both variables and their interaction are significant at the 0.05 level or better. This is consistent with the previous results of the laboratory experiments.[8]

Table 7

ANOVA of Responses to Individual Aircraft Sounds

Source	Degrees of Freedom	Sum of Squares	Mean Sum of Squares	F	P
Setting/Level	1	459.43	459.43	147.86	<0.01
Onset Rate	5	767.00	153.40	49.37	<0.01
Interaction	5	41.21	8.24	2.65	<0.05
Residual	2,148	6,674.17	3.11		
Total	2,159	7,941.81			

Although the setting/level variable may appear to be a confounding of two separate variables – indoor versus outdoor setting and 95 dB versus 110 dB SELs – the combination of setting and level does represent what actually happens in the real world. That is, indoor aircraft sound levels are typically at least 15 dB below the corresponding outdoor sound levels because of the normal sound attenuation provided by a building's structure.

Table 8 shows the means and standard deviations of the responses for the setting/level variable, for the onset rate variable, and for the interaction of the two variables. Table 9 shows the differences between the means of the responses for the setting/level and the onset rate variables. These differences are evaluated by

Table 8

Means and Standard Deviations of
Responses to Individual Aircraft Sounds

(a) For Setting/Level Variable

Setting/Level	Mean	Std. Dev.	Responses
Outdoors/110 dB SEL	5.32	1.78	720
Indoors / 95 dB SEL	4.34	1.90	1,440

(b) For Onset Rate Variable (360 Responses)

Onset Rate	Mean	Std. Dev.
1.9 dB/sec	4.03	1.93
16 dB/sec	4.14	1.83
22 dB/sec	4.31	1.83
42 dB/sec	4.77	1.79
68 dB/sec	4.96	1.84
152 dB/sec	5.77	1.73

(c) For Interactions

Onset Rate	Setting/Level			
	Outdoors/110 dB (120 Responses)		Indoors/95 dB (240 Responses)	
	Mean	Std. Dev.	Mean	Std. Dev.
1.9 dB/sec	4.88	1.79	3.60	1.86
16 dB/sec	4.86	1.83	3.78	1.72
22 dB/sec	5.04	1.72	3.95	1.78
42 dB/sec	5.60	1.69	4.35	1.69
68 dB/sec	5.41	1.65	4.73	1.89
152 dB/sec	6.10	1.70	5.61	1.72

the Tukey HSD test[9] at the 0.05 level of significance. (The Tukey-Kramer modification of the HSD test[9] was used for Table 9(a), since the sample n's are unequal.) Significant differences are indicated in Table 9 by boldface print.

Table 9(b) shows a significant onset rate effect at onset rates of 42 dB/sec and higher. This is also consistent with the previous results of the laboratory experiments.[8]

Table 9

Differences Between Means of Responses to Individual Aircraft Sounds

(a) Setting/Level Variable

	Indoors/95 dB SEL
Outdoors/110 dB SEL	**0.98**

(A mean difference of 0.16 is significant at the 0.05 level.)

(b) Onset Rate Variable

	16 dB/sec	**22 dB/sec**	**42 dB/sec**	**68 dB/sec**	**152 dB/sec**
1.9 dB/sec	0.11	0.28	**0.74**	**0.93**	**1.74**
16 dB/sec		0.17	**0.63**	**0.82**	**1.63**
22 dB/sec			**0.46**	**0.65**	**1.46**
42 dB/sec				0.19	**1.00**
68 dB/sec					**0.81**

(A mean difference of 0.37 is significant at the 0.05 level.)

The subset of the individual response data corresponding to the indoor setting and nominal SEL 95 dB was further analyzed to determine if there is any significant dependence of response on the activity in which the participants were engaged. Table 10 presents an ANOVA of these indoor data with the main variables of onset rate and activity.

Table 10

ANOVA of Responses to Individual Indoor Aircraft Sounds

Source	Degrees of Freedom	Sum of Squares	Mean Sum of Squares	F	P
Onset Rate	5	662.05	132.41	42.49	<0.01
Activity	2	16.20	8.10	2.60	NS
Interaction	10	48.91	4.89	1.57	NS
Residual	1,422	4,430.89	3.12		
Total	1,439	5,158.05			

The onset rate variable is significant at the 0.01 level; the activity variable and the interaction are not significant (NS) at the 0.05 level. Thus it is clear that, at least for the types of activities considered here, annoyance response does not depend on activity.

Table 11 shows the means and standard deviations of the responses for the onset rate variable, for the activity variable, and for the interaction of the two variables for the indoor subset of data.

5.1.3 Regression Analysis

Figure 11 shows the annoyance rating, averaged over all participants, as a function of onset rate and setting/level. The error bars represent ±2 standard errors of the mean about each average value. The standard error of the mean for a given onset rate, σ_m, is given by the standard deviation of the distribution for that onset rate in Table 8(c) divided by the square root of the number of responses for the corresponding setting/level.

Table 11

Means and Standard Deviations of
Responses to Individual Indoor Aircraft Sounds

(a) For Onset Rate Variable (240 Responses)

Onset Rate	Mean	Std. Dev.
1.9 dB/sec	3.60	1.84
16 dB/sec	3.78	1.72
22 dB/sec	3.95	1.77
42 dB/sec	4.35	1.68
68 dB/sec	4.73	1.88
152 dB/sec	5.60	1.72

(b) For Activity Variable

Activity	Mean	Std. Dev.	Responses
Puzzle	4.23	1.92	720
Television	4.41	1.81	360
Reading	4.47	1.91	360

(c) For Interactions

Onset Rate	Activity					
	Puzzle (120 Responses)		Television (60 Responses)		Reading (60 Responses)	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
1.9 dB/sec	3.38	1.78	4.02	1.77	3.63	2.01
16 dB/sec	3.72	1.79	4.05	1.63	3.65	1.65
22 dB/sec	3.68	1.81	4.12	1.71	4.33	1.71
42 dB/sec	4.30	1.68	4.45	1.76	4.37	1.63
68 dB/sec	4.61	1.89	4.55	1.94	5.17	1.74
152 dB/sec	5.72	1.60	5.30	1.76	5.68	1.88

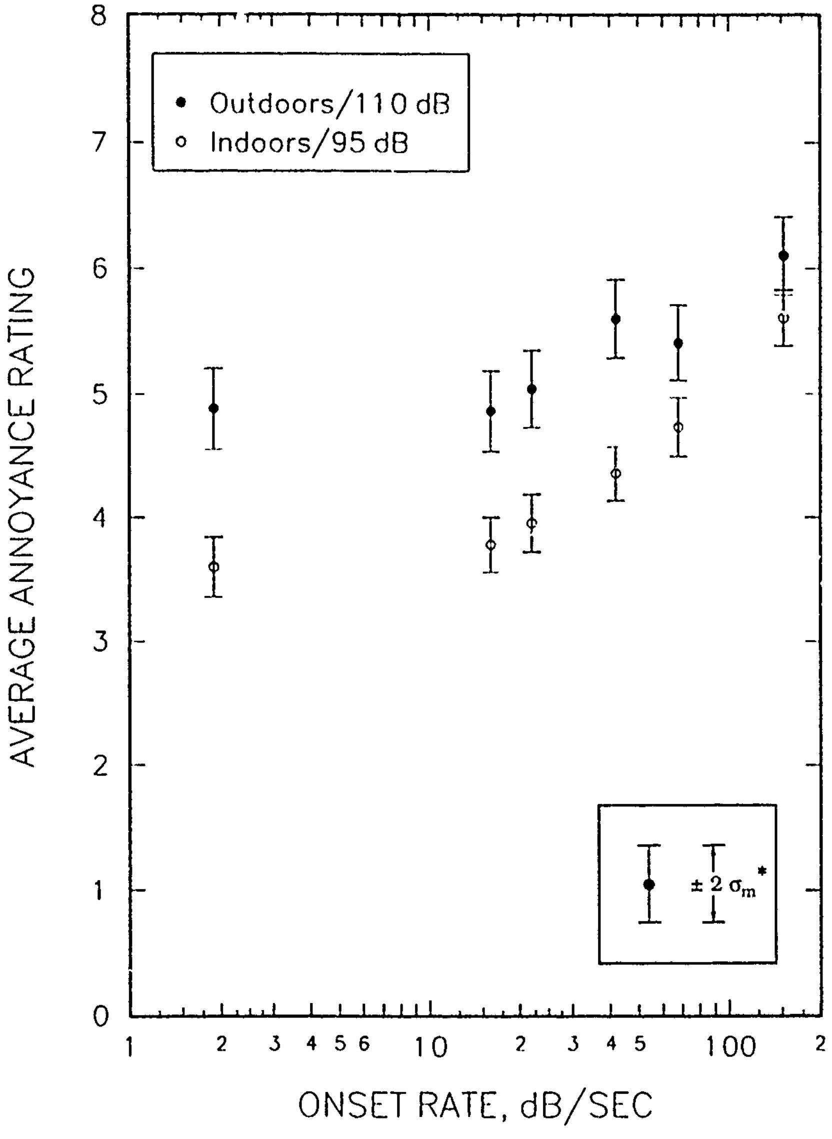

Figure 11. Annoyance Rating Versus Onset Rate and Setting/Level, Averaged Over All Participants.

(* σ_m is the Standard Error of the Mean for the data set.)

Figure 12 shows the annoyance rating for the indoor subset of data, arranged over all participants, as a function of onset rate and activity. For clarity, error bars have been omitted from this figure. No particular trend is seen for activity, which is consistent with the ANOVA result above.

A grid search procedure was used to fit various least-squares models to the data in Figure 11. Two different pairs of models are shown in Table 12, which lists the fitted parameters and the associated sum of the squared residuals of the data about the model.

- Table 12(a) lists the parameters for a pair of linear fits of average annoyance rating to the logarithm of the onset rate. Figure 13 shows plots of these models superimposed on the data from Figure 11.

- Table 12(b) lists the parameters for a pair of two-part models: a constant average annoyance rating to an onset rate OR_1, followed by a linear function of the logarithm of the onset rate. Figure 14 shows plots of these models superimposed on the data from Figure 11.

An examination of the sum of the squared residuals in Table 12 shows that the model in Table 12(b) is a better fit to the data than the model in Table 12(a).

The data here do not exhibit an upper plateau. Thus, from these data it is not possible to determine where, or whether, an upper cap to the annoyance rating occurs.

5.1.4 Onset Rate Adjustment to SEL

As shown in Section 5.1.3, the data obtained in this experiment does not extend to high enough onset rates to define an upper cutoff to the onset rate adjustment. Since an upper cutoff of 150 dB/sec was assumed in the previous laboratory experiments,[8] similar upper cutoffs will be assumed here at the maximum fitted annoyance ratings indicated in Figure 14 for the outdoors/110 dB and the indoors/95 dB data. These cutoffs are illustrated in Figure 15.

In this figure, the annoyance rating difference between that maximum and the lower constant term is 1.17 rating points for the outdoors/110 dB data set and 1.87 rating points for the indoors/95 dB data set.

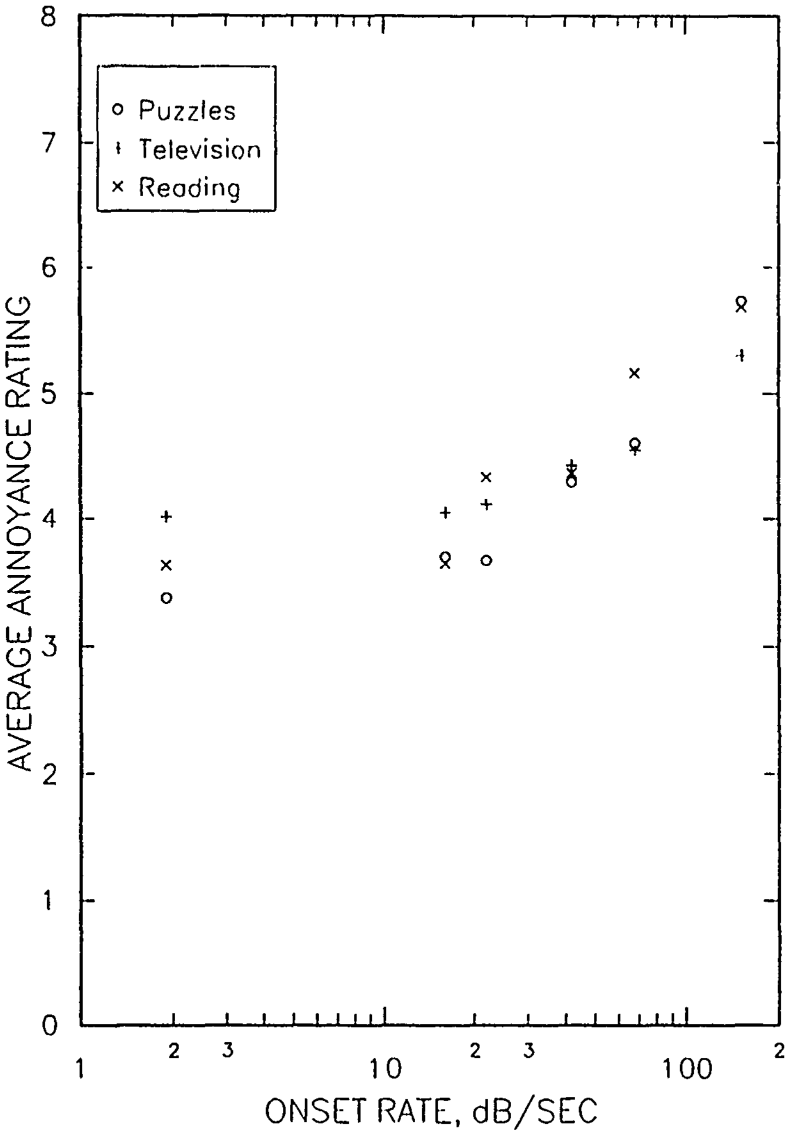

Figure 12. Annoyance Rating Versus Onset Rate and Activity for Indoor '95 dB Data, Averaged Over All Participants.

Table 12

Least-Squares Fit Models of Annoyance Rating, AR, Versus Onset Rate, OR

(a) A Logarithmic Increase of Annoyance Rating With Onset Rate:

$$AR = A \bullet \log_{10}(OR) + B$$

	Outdoors/110 dB	Indoors/95 dB
Parameter A	0.60	1.00
Parameter B	4.47	2.93
Sum of Squared Residuals	0.378	0.673

(b) A Constant Annoyance Rating, AR_1, to an Onset Rate OR_1, Followed by a Logarithmic Increase With Onset Rate:

$$AR = \begin{cases} AR_1 , & OR \le OR_1 , \\ AR_1 + A \bullet \log_{10}(OR/OR_1), & OR > OR_1 . \end{cases}$$

	Outdoors/110 dB	Indoors/95 dB
Parameter AR_1	4.89	3.63
Parameter OR_1	16.0	14.9
Parameter A	1.19	1.84
Sum of Squared Residuals	0.100	0.050

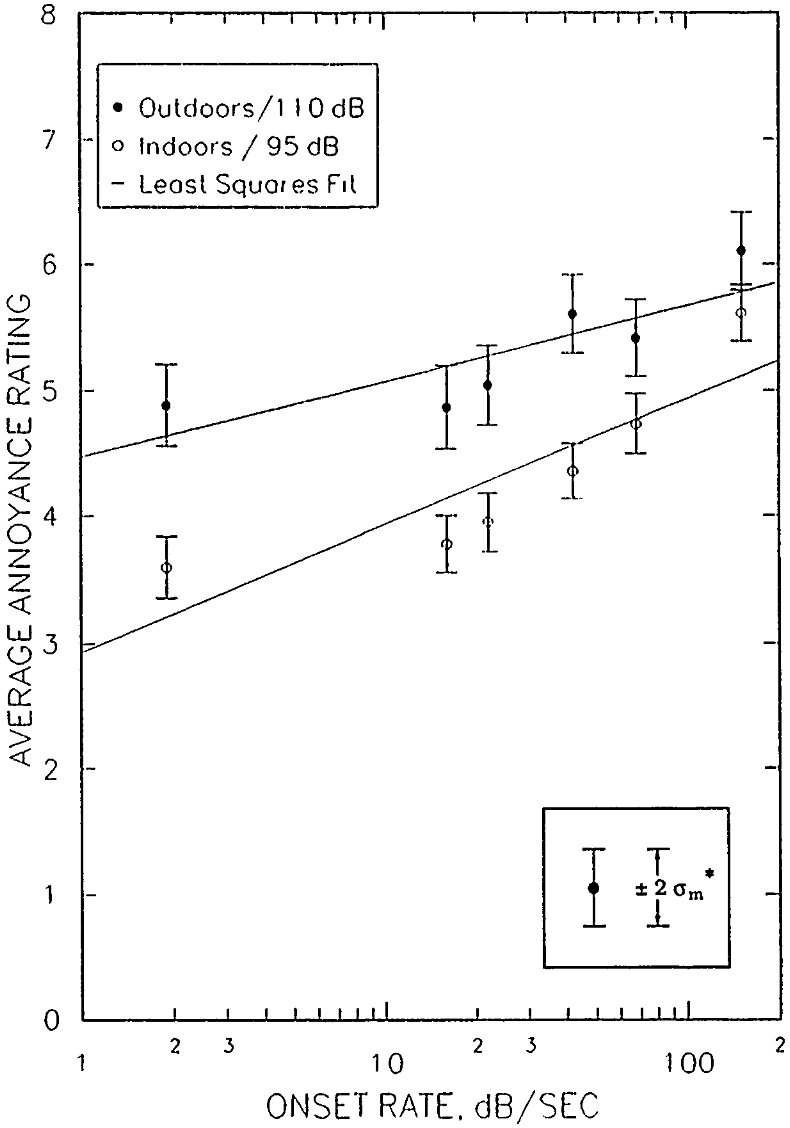

Figure 13. Logarithm Model of Annoyance Versus Onset Rate.

(* σ_m is the Standard Error of the Mean for the data set.)

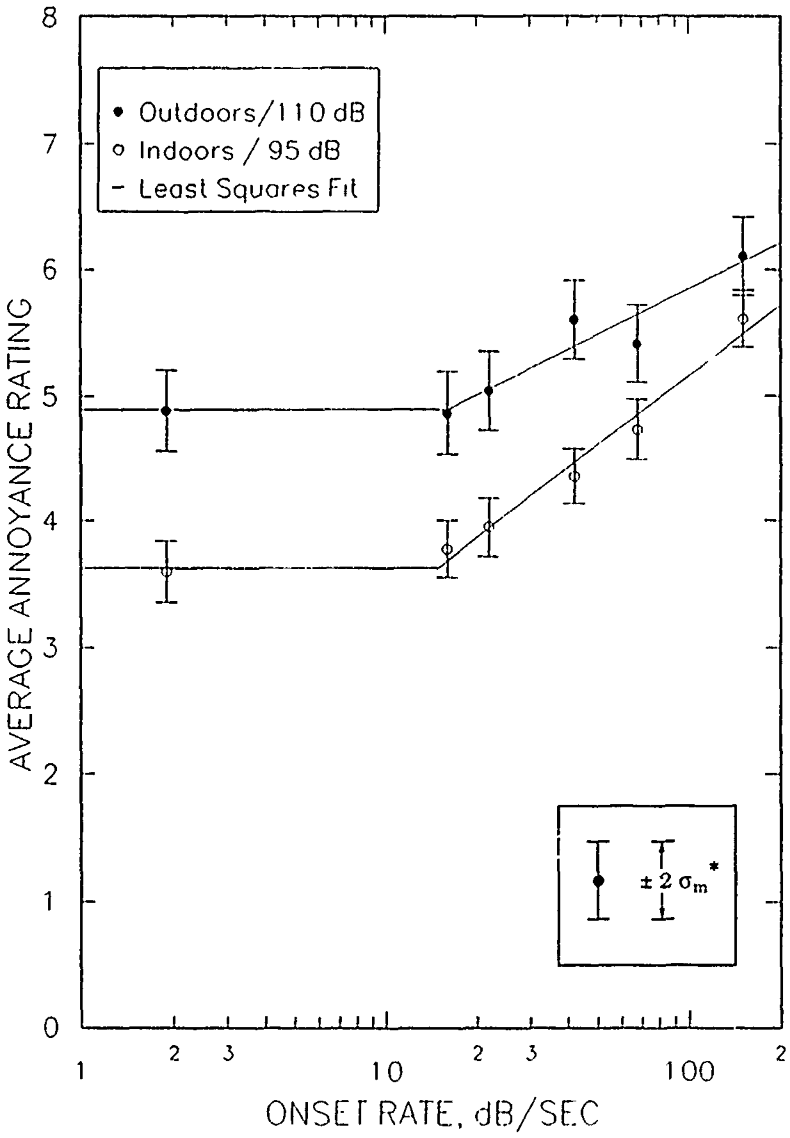

Figure 14. Constant Plus Logarithm Model of Annoyance Versus Onset Rate.

(* σ_m is the Standard Error of the Mean for the data set.)

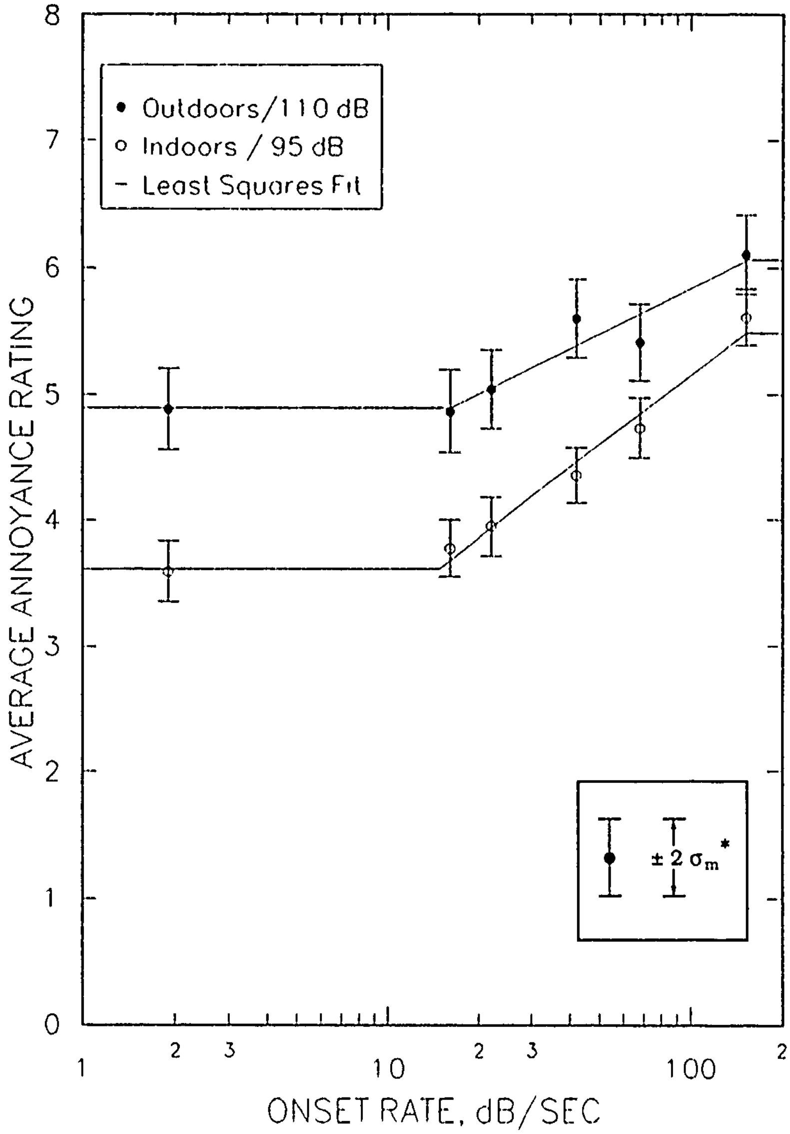

Figure 15. Annoyance Model of Figure 14 With Cutoff as Discussed in Text.

(* σ_m is the Standard Error of the Mean for the data set.)

To convert these rating point differences to SEL onset rate adjustments in dB, a conversion between annoyance rating and SEL must be used. It is inappropriate to use the difference between the two data sets in Figure 15 for this conversion, since both SEL (95 to 110 dB) and setting (indoor to outdoor) vary between them.

Instead, the conversions obtained in the outdoor (K2) and indoor (K1) "kernel" experiments in the laboratory study[8] – 6.6 dB/rating point and 7.4 dB/rating point, respectively – was used. The results are maximum SEL onset rate adjustments of 7.7 dB for the outdoors/110 dB data set and 13.8 dB for the indoors/95 dB data set. The average maximum adjustment for the two data sets is 10.8 dB.

Figure 16 shows an average SEL onset rate adjustment based on the models in Figure 15. The adjustment, ADJ, in dB as a function of onset rate, OR, in dB/sec is given by:

$$ADJ = \begin{cases} 0, & \text{for } OR \le 15 \\ 11.0 \log_{10}(OR) - 12.9, & \text{for } 15 \le OR \le 150 \\ 11, & \text{for } OR \ge 150 \end{cases}$$

This model is similar to that developed from the results of the laboratory experiments.[8] The only difference is that the lower plateau, which extends to 30 dB/sec for the laboratory study, extends only to 15 dB/sec here.

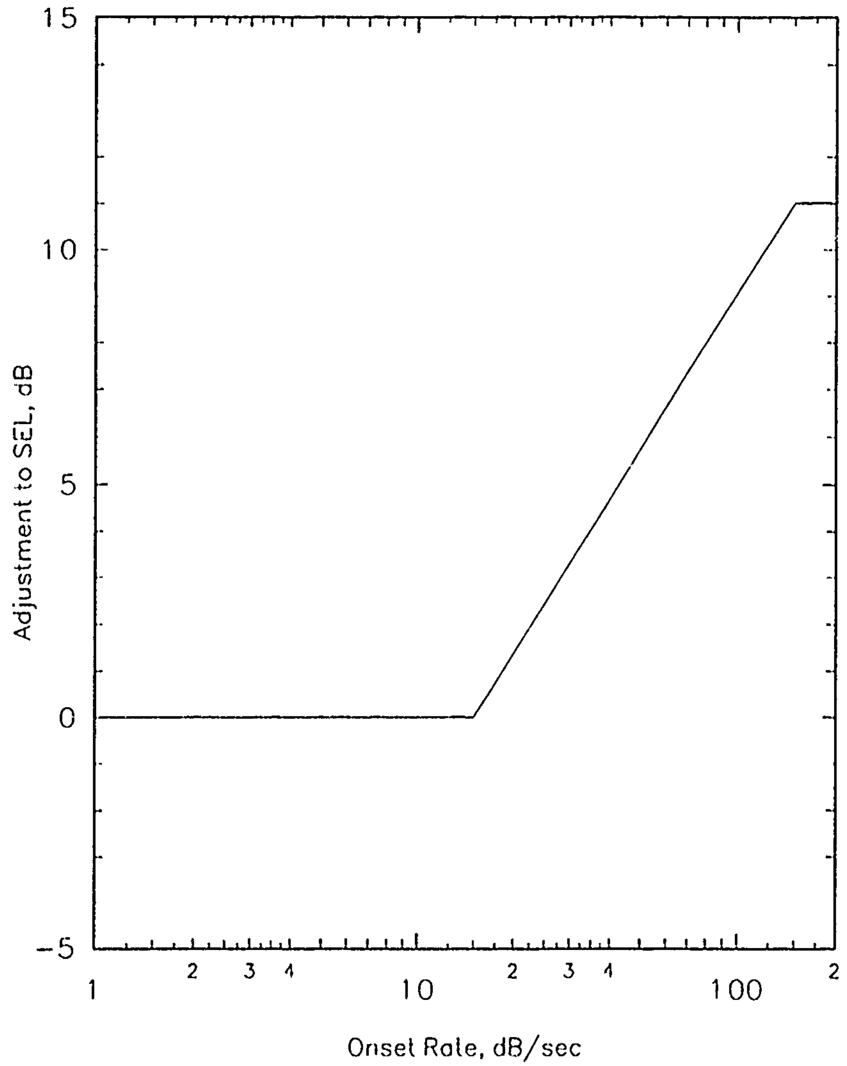

Figure 16. Onset Rate Adjustment From Rented Home Experiment.

5.2 Response to Hourly Sessions

Table 13 summarizes the responses to the 12 one-hour sessions, averaged over all participants. The number of sounds presented in each session ranged from one to five. Table 13(a) shows the sounds presented in each session and the averages for each session, using the identification numbers given in Table 6. Table 13(b) combines the data from those sessions having the same number of sounds to provide the average response as a function of setting/level and number of sounds presented.

Table 13

Average Response Data for Hourly Sessions

(a) Average for Each Session

Session ID	Identification of Sounds Presented	Outdoors/110 dB (20 Responses)		Indoors/95 dB (40 Responses)	
		Mean	Std. Dev.	Mean	Std. Dev.
1	4	5.6	1.7	3.5	1.8
2	6	6.0	2.2	4.6	2.1
3	5, 6	5.4	1.8	4.6	1.9
4	3, 5	4.6	1.5	4.1	1.9
5	2, 3, 5	4.4	2.0	4.1	1.5
6	1, 3, 2	5.1	1.6	3.6	1.6
7	1, 6, 4	5.3	2.0	4.2	1.6
8	6, 5, 4	5.5	1.4	4.5	1.6
9	4, 1, 3, 2	4.5	2.2	3.6	1.4
10	1, 2, 6, 4	5.2	1.7	4.5	1.5
11	2, 3, 1, 6, 5	5.2	1.4	4.6	1.7
12	5, 2, 1, 3, 4	4.8	1.3	4.3	1.7

(b) Average as a Function of the Number of Sounds Presented

Number of Sounds Presented	Outdoors/110 dB			Indoors/95 dB		
	Mean	Std. Dev.	No.	Mean	Std. Dev.	No.
1	5.8	2.0	40	4.1	2.0	80
2	5.0	1.7	40	4.4	1.9	80
3	5.1	1.8	80	4.1	1.6	160
4	4.9	2.0	40	4.1	1.5	80
5	5.0	1.3	40	4.5	1.7	80

Table 14 is the ANOVA of the response data shown in the lower portion of Table 13. This is a two-way analysis with the main variables of setting/level and number of sounds presented.

Table 14

ANOVA of Responses to Hourly Sessions

Source	Degrees of Freedom	Sum of Squares	Mean Sum of Squares	F	P
Setting/Level	1	132.42	132.42	43.85	<0.01
No. of Sounds	4	10.21	2.55	0.85	NS
Interaction	4	23.92	5.98	1.98	NS
Residual	710	2,143.77	3.02		
Total	719	2,310.32			

The setting/level variable is significant at the 0.01 level; the number of sounds presented and the interaction are not significant (NS) at the 0.05 level of confidence.

Figure 17 shows the annoyance rating for hourly sessions, averaged over all participants, as a function of the number of sounds presented and setting/level. The error bars represent ±2 standard errors of the mean about each average value. The standard error of the mean for a given data set, σ_m, is given by the standard deviation of the distribution for that data set in Table 13(b) divided by the square root of the number of responses for the corresponding setting/level.

Consistent with the ANOVA of these data, no clear dependence of annoyance rating on the number of sounds presented is seen in this figure.

This result should not be interpreted as showing that annoyance is not affected by the frequency of occurrence of aircraft sounds above and beyond the effect due to the setting/level. Rather, it should be interpreted as not showing that there is such an effect under the test conditions used in this experiment.

The primary goal of the rented home experiment was to study annoyance to low-flying aircraft sounds under more realistic conditions than existed in the laboratory experiments. The study of the effect on annoyance of the frequency of

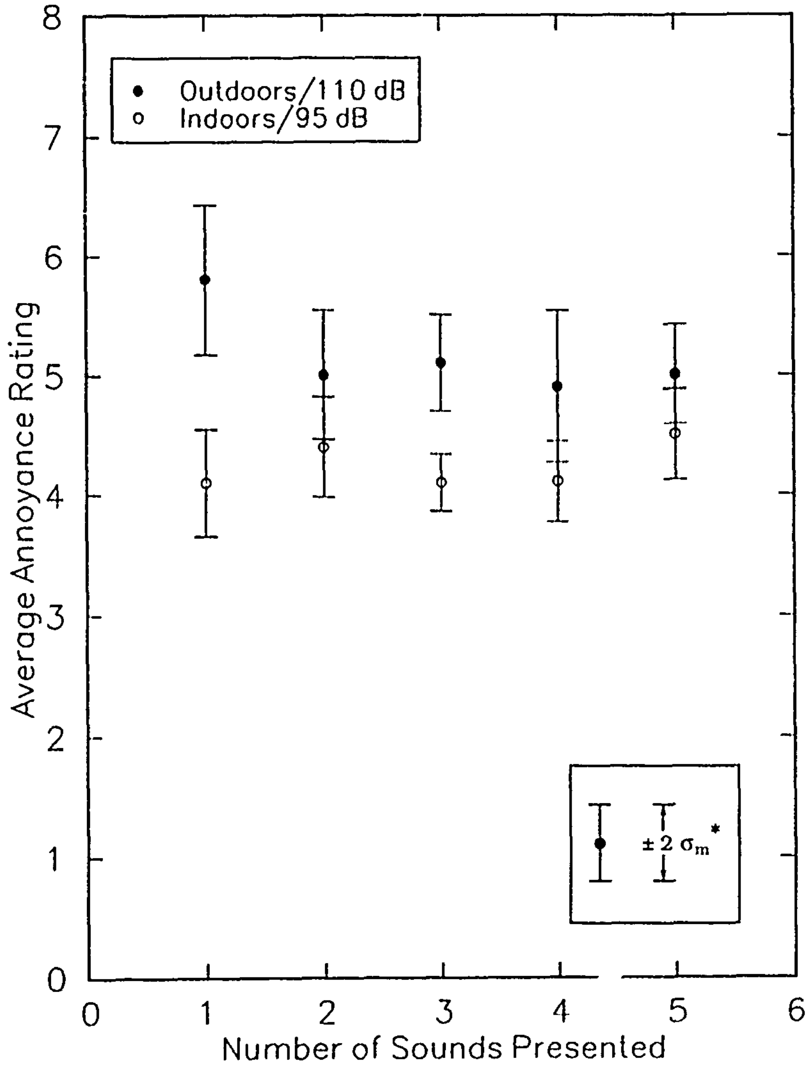

Figure 17. Annoyance Rating for Hourly Sessions Versus Number of Sounds Presented, Averaged Over All Participants.

(* σ_m is the Standard Error of the Mean for the data set.)

occurrence and the irregularity of these sounds was a secondary goal. Consequently, the results presented above should be considered very preliminary, since the basic experimental design favored the primary goal rather than the secondary one.

To accomplish the primary goal, the design of the rented home experiment employed individual aircraft sounds that had the same nominal SEL - 95 dB indoors and 110 dB outdoors. As a result, the L_{eq} for each one-hour session was highly correlated with the number of events presented in that session. Those sessions with the greater number of events had higher L_{eq} values. Thus the only statistical analysis possible was to compare the outdoors/110 dB annoyance responses with the indoors/95 dB responses.

To more accurately assess if frequency of occurrence has an effect on annoyance beyond the effect of the associated integrated sound level, it is necessary to design an experiment in which the SELs of the individual sound events vary, so that hourly periods with different numbers of event presentations will have the same values of L_{eq}. Then an ANOVA with sound level and number of presentations as the independent variables can be carried out.

In addition, although the normal irregularity of this type of sound event was included in the experimental design by the use of random interstimulus intervals, no attempt was made to systematically vary the amount of irregularity to determine its effect on annoyance rating alone. To accomplish this, it would be necessary to design an experiment in which each session had the same L_{eq} and number of events but different degrees of irregularity. That is, in some sessions the stimuli would occur at periodic or near-periodic intervals, while in other sessions the stimuli would occur at random, irregular intervals.

5.3 Onset Rate Adjusted L_{dn} Versus Unadjusted L_{dn}

The primary reason for the current investigations of human annoyance to noise from low-altitude training flight operations is to determine if the Schultz curve,[1,2] which relates annoyance to L_{dn}, is directly applicable to situations involving infrequent, irregular, sudden, short, loud noise events. The onset rate adjustment for SEL is intended to provide an onset rate adjusted L_{dn}, which is expected to more closely correlate with the predictions of the Schultz curve.

In this section, the annoyance ratings for the hourly sessions are plotted as a function of the corresponding normal hourly L_{eq} and as a function of the onset rate adjusted hourly L_{eq}. The resultant curves are then compared with the Schultz curve. (Since none of the data were acquired during nighttime hours, hourly L_{eq} and L_{dn} are equivalent in this case, since the 10 dB nighttime penalty does not apply.)

The Schultz curve does not relate L_{dn} to the average annoyance rating; rather it relates L_{dn} to the "percent highly annoyed". Appendix A provides the cumulative distributions of the session annoyance ratings for the 12 one-hour sessions for the Outdoors/110 dB and the Indoors/95 dB data from which the percent highly annoyed were computed. It also provides the detailed calculations of the unadjusted and onset-rate-adjusted L_{eq} values for each session. The percent highly annoyed is identified with ratings of 6, 7, and 8.

Table 15 summarizes the results of the calculations in Appendix A. It tabulates, for both the Outdoors/115 dB and the Indoors/95 dB data, the measured percent highly annoyed, the unadjusted L_{eq}, the onset-rate-adjusted L_{eqr} using the onset rate adjustment from the rented home experiment in Figure 16, and the onset-rate-adjusted L_{eqr} using the onset rate adjustment from the interim metric in Figure 1(a).

Table 15

Measured Percent Highly Annoyed Versus
Unadjusted and Onset-Rate-Adjusted Leq

Session I.D.	Outdoors/110 dB SEL				Indoors/95 dB SEL			
	Meas-ured %HA	Meas-ured Leq	Leqr Based on Rented Home Onset Rate Adj.	Leqr Based on Interim Metric Onset Rate Adj.	Meas-ured %HA	Meas-ured Leq	Leqr Based on Rented Home Onset Rate Adj.	Leqr Based on Interim Metric Onset Rate Adj.
1	70.0	73.6	78.5	78.6	15.0	59.2	64.1	64.2
2	75.0	70.3	81.3	75.3	45.0	59.0	70.0	64.0
3	55.0	74.8	83.9	79.8	45.0	62.2	71.5	67.2
4	35.0	76.5	81.3	80.3	22.5	62.3	67.7	66.4
5	40.0	78.5	82.0	81.3	15.0	64.1	68.4	67.3
6	40.0	79.6	80.2	80.7	12.5	64.9	65.5	65.9
7	55.0	78.4	83.8	81.4	25.0	65.2	71.5	68.3
8	65.0	77.2	84.9	82.2	37.5	63.8	72.2	68.8
9	45.0	80.5	82.4	82.7	7.5	66.1	68.0	68.3
10	55.0	79.8	84.3	82.3	27.5	65.8	71.6	67.5
11	50.0	80.7	85.5	83.2	40.0	66.7	72.4	69.6
12	35.0	80.9	84.0	83.4	30.0	66.9	70.4	69.8

In Figure 18, the percent highly annoyed is plotted as a function of the L_{eq} values. The Schultz curve (obtained by using the analytic form provided in References 10 and 11) is also shown on this figure. Note that, although the Schultz curve relates annoyance to L_{dn}, in this experiment L_{dn} and L_{eq} are equivalent, since there was no nighttime data involved. Thus it is appropriate to plot the Schultz curve on a graph of percent highly annoyed versus L_{eq}.

Figure 18 shows that the Schultz curve underestimates the annoyance to the type of sounds presented in this study. In addition, there is considerable scatter of the data about the Schultz curve.

In Figure 19, the percent highly annoyed is plotted as a function of the L_{eqr} values obtained from the rented home onset rate adjustment in Figure 16. The Schultz curve is again shown on this figure. The data now more closely straddles the Schultz curve than in Figure 18. The onset rate adjustment has considerably improved the fit of the data to the Schultz curve and reduced the amount of scatter about the curve.

Figure 20 is similar to Figure 19 except that the interim metric onset rate adjustment (see Figure 1(a)) has been used to calculate the L_{eqr} values. The fit to the Schultz curve, although better than that in Figure 18, is not as good as that in Figure 19.

These facts are shown quantitatively in Table 16, which provides the root-mean-squared (RMS) values of the residuals between the measured percent highly annoyed and the Schultz curve prediction for Figures 18, 19, and 20. The onset rate adjustment based on the rented home experiment provides the smallest RMS residual.

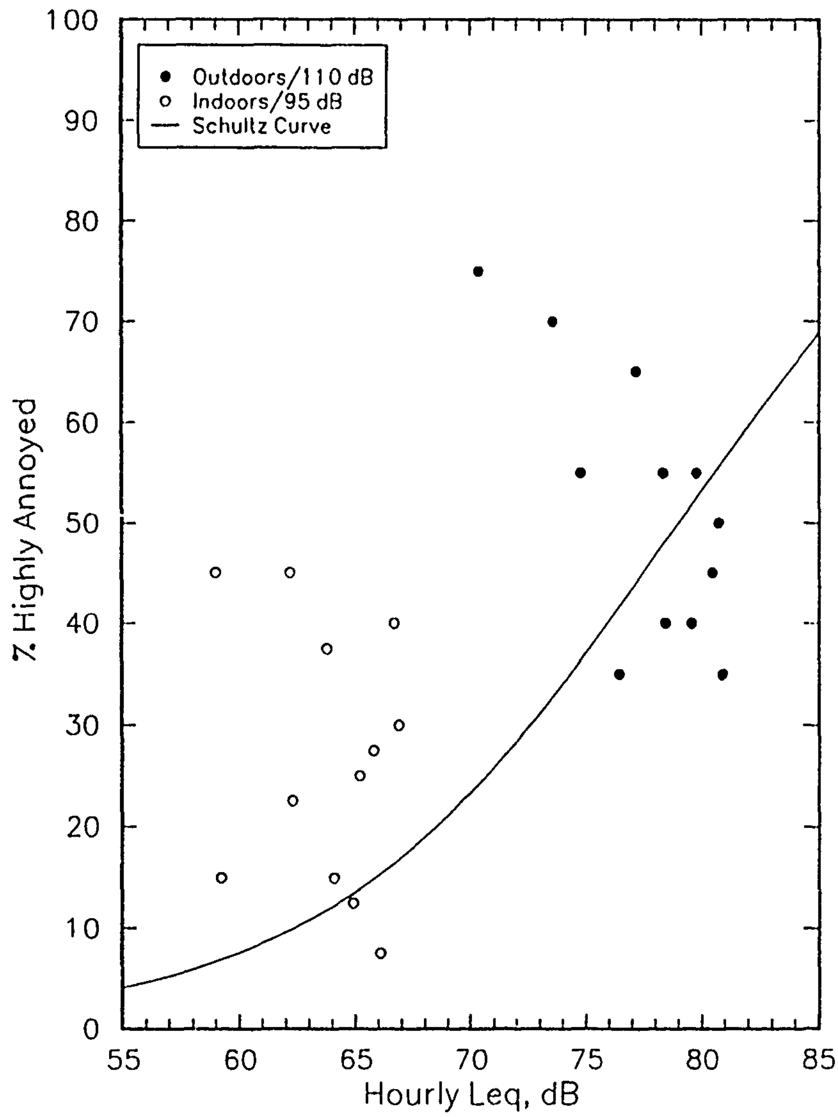

Figure 18. Percent Highly Annoyed (Ratings 6, 7, and 8) Versus L_{eq}.

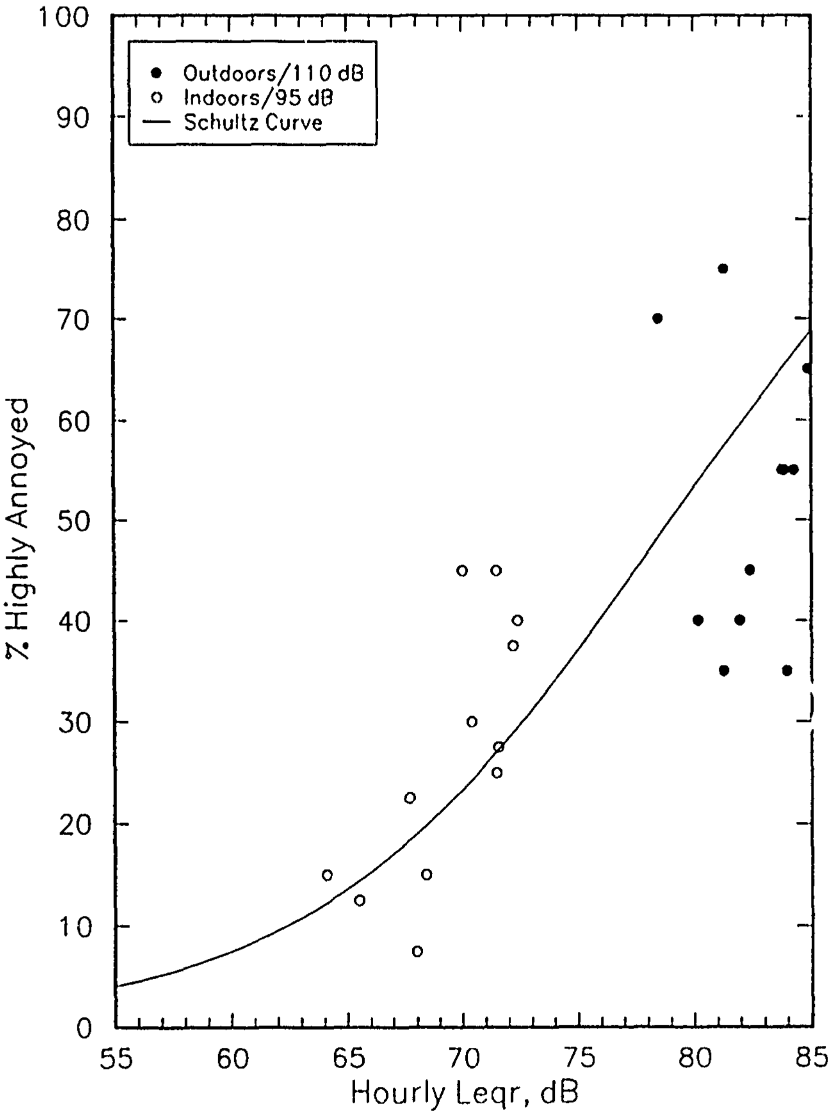

Figure 19. Percent Highly Annoyed (Ratings 6, 7, and 8) Versus L_{eqr} (Using Rented-Home Experiment Onset-Rate Adjustment).

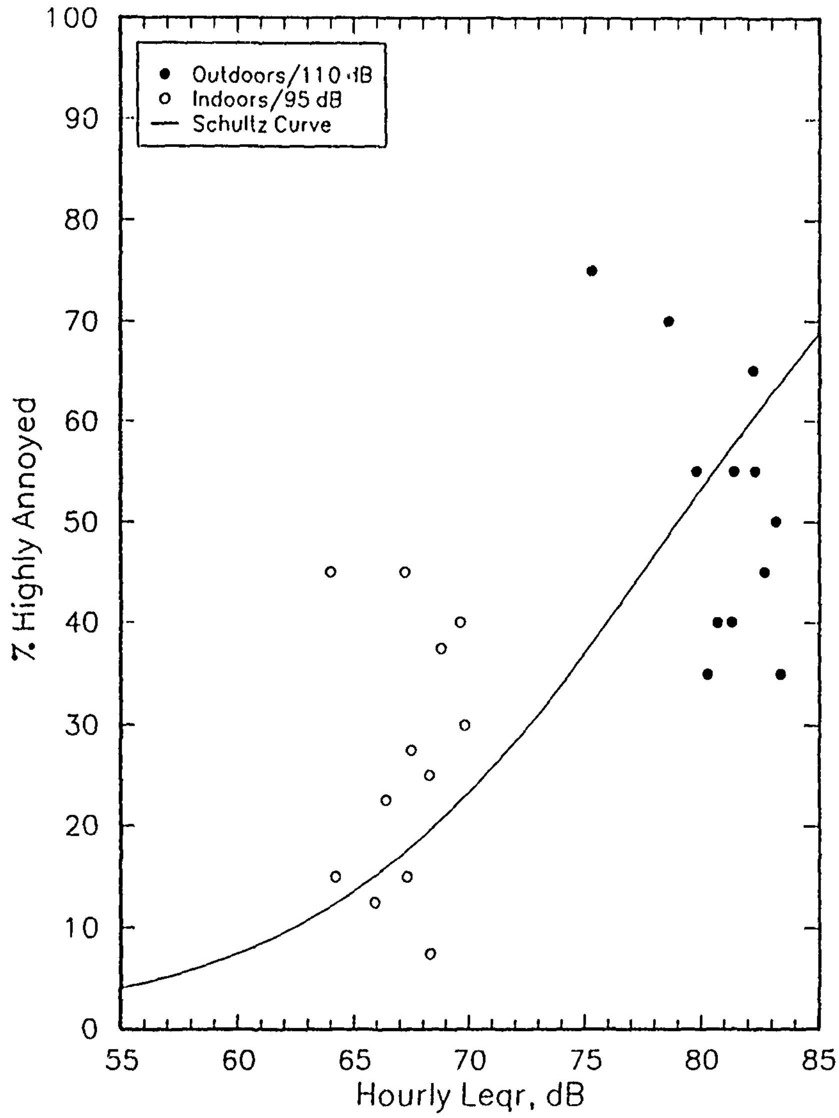

Figure 20. Percent Highly Annoyed (Ratings 6, 7, and 8) Versus L_{eqr} (Using Interim Metric Onset-Rate Adjustment).

Table 16

Comparison of Measured Percent Highly Annoyed
With Percent Highly Annoyed Predicted by Schultz Curve

Measured %HA	Without OR Correction			With Rented Home OR Correction			With Interim Metric OR Correction		
	Leq*	**Predicted %HA****	**Squared Residual**	**Leqr***	**Predicted %HA****	**Squared Residual**	**Leqr***	**Predicted %HA****	**Squared Residual**
7.5	66.1	15.3	60.8	68.0	18.9	130.7	68.3	19.5	144.4
12.5	64.9	13.4	0.9	65.5	14.4	3.6	65.9	15.1	6.6
15.0	59.2	6.8	66.5	64.1	12.3	7.3	64.2	12.4	6.5
15.0	64.1	12.3	7.4	68.4	19.7	22.1	67.3	17.5	6.4
22.5	62.3	9.9	158.2	67.7	18.4	16.8	66.4	15.9	43.4
25.0	65.2	13.8	124.8	71.5	27.1	4.3	68.3	19.6	28.7
27.5	65.8	15.0	157.3	71.6	27.3	0.1	67.5	17.9	91.9
30.0	66.9	16.8	173.5	70.4	24.3	32.4	69.8	22.8	51.2
35.0	76.5	41.6	43.8	81.3	57.4	502.6	80.3	54.2	370.4
35.0	80.9	56.2	449.9	84.0	66.0	960.5	83.4	64.2	851.1
37.5	63.8	11.9	655.4	72.2	28.8	75.5	68.8	20.7	281.6
40.0	78.5	48.2	67.4	82.0	59.9	394.5	81.3	57.5	305.5
40.0	79.6	51.8	139.8	80.2	54.0	197.3	80.7	55.5	239.8
40.0	66.7	16.5	553.0	72.4	29.6	108.5	69.6	22.3	313.6
45.0	80.5	54.8	96.9	82.4	60.9	251.8	82.7	61.9	284.4
45.0	59.0	6.7	1468.5	70.0	23.4	466.0	64.0	12.2	1078.3
45.0	62.2	9.8	1242.5	71.5	27.1	318.8	67.2	17.3	767.8
50.0	80.7	55.7	32.0	85.5	70.3	410.9	83.2	63.6	184.7
55.0	74.8	36.4	346.8	83.9	65.7	113.5	79.8	52.5	6.1
55.0	78.4	47.8	51.5	83.8	65.3	105.8	81.4	57.7	7.4
55.0	79.8	52.5	6.1	84.3	66.8	140.1	82.3	60.7	32.3
65.0	77.2	43.9	444.4	84.9	68.6	13.0	82.2	60.4	21.5
70.0	73.6	32.8	1382.7	78.5	48.4	465.6	78.6	48.8	451.5
75.0	70.3	24.1	2587.7	81.3	57.6	302.7	75.3	38.1	1362.0
Mean of Squared Residuals			429.9			210.2			289.1
RMS of Residuals			20.7			14.5			17.0

* Ldn and Leq are equivalent for these data.
** Predicted %HA = 100/(1 + exp (10.43 – 0.132 Ldn))

5.4 Comparison of Responses to Individual Aircraft Sounds in Each Hourly Session with Session Responses

In order to obtain some insight into how responses to individual noise events during a given period may integrate to form a cumulative response for that period, the responses to the individual interior aircraft sounds in each hourly session (each sound having a nominal SEL of 95 dB) were compared with the corresponding session responses.

Appendix B provides, for each of the 12 hourly sessions, the averages of these individual ratings for each participant, the session rating for each participant, and the corresponding difference between the two. The averages and standard deviations of these parameters, over all participants, are also given. These data are summarized in Table 17.

This appendix also provides, for each of the 12 hourly sessions, the percent highly annoyed based on the averages of the individual ratings and the percent highly annoyed based on the session ratings. As in Section 5.3, percent highly annoyed is identified with ratings of 6, 7, and 8. These data are also summarized in Table 17.

Table 17

Comparison of Responses to Individual Aircraft Sounds in Each Hourly Session with Session Responses

Sess. I.D.	Sounds	No. of Sounds	Avg. of Individual Ratings			Session Ratings			SRTG –IRTG	%HA		S%HA –I%HA
			No.	Avg.	Std.	No.	Avg.	Std.		Avg.Indv.	Session	
1	4	1	40	3.83	1.71	40	3.53	1.81	-0.30	17.50	15.00	-2.50
2	6	1	40	5.38	1.73	40	4.60	2.11	-0.78	52.50	45.00	-7.50
3	5, 6	2	40	5.06	1.75	40	4.55	1.88	-0.51	50.00	45.00	-5.00
4	3, 5	2	40	4.46	1.88	40	4.08	1.97	-0.39	45.00	22.50	-22.50
5	2, 3, 5	3	40	4.62	1.01	40	4.13	1.47	-0.49	30.00	15.00	-15.00
6	1, 3, 2	3	40	3.66	1.63	40	3.63	1.66	-0.03	25.00	12.50	-12.50
7	1, 6, 4	3	40	4.54	1.48	40	4.25	1.61	-0.29	42.50	25.00	-17.50
8	6, 3, 4	3	40	4.80	1.64	40	4.50	1.63	-0.30	47.50	37.50	-10.00
9	4, 1, 3, 2	4	40	3.61	1.36	40	3.58	1.41	-0.03	12.50	7.50	-5.00
10	1, 2, 6, 4	4	40	4.42	1.38	40	4.50	1.55	0.08	30.00	27.50	-2.50
11	2, 3, 1, 6, 5	5	40	4.49	1.70	40	4.58	1.75	0.09	45.00	40.00	-5.00
12	5, 2, 1, 3, 4	5	40	4.30	1.84	40	4.28	1.75	-0.03	37.50	30.00	-7.50
	Average			4.43			4.18		-0.25	36.25	26.88	-9.38
	St. Dev.			0.53			0.41		0.27	13.12	12.63	6.52

Table 18(a) is an analysis of variance of the difference between the session ratings and the corresponding average of individual ratings and the number of sounds in each session. Table 18(b) is an analysis of variance of the difference between the percent highly annoyed based on the session ratings and the percent highly annoyed based on the averages of the individual ratings and the number of sounds in each session.

Although the number of sounds variable is not significant at the 0.05 level in either case, it is almost so in the former, being significant at the 0.0514 level.

Figure 21 is a plot, showing the best linear least-squares fit, to the average session rating minus average individual rating as a function of the number of sounds in the session. Figure 22 is a similar plot of the percent highly annoyed based on session ratings minus the percent highly annoyed based on the averages of individual ratings as a function of the number of sounds in the session.

Table 18(a) and Figure 21 show a relationship between the indicated difference between average ratings and the number of sounds in the session, while Table 18(b) and Figure 22 show no relationship between the indicated difference between percent highly annoyed values and the number of sounds in the session. It is not obvious why these results should have occurred. Clearly, more work is needed to better understand how individual responses integrate into session responses.

5.5 Post-Experiment Questionnaire

Appendix C provides a summary of the Post-Experiment Questionnaire responses. These responses generally confirm the quantitative psychoacoustic data presented above. A detailed analysis of these responses is presented in Appendix D.

Table 18(a)

ANOVA of Difference Between Session Ratings and Average of Individual Ratings

Source	Degrees of Freedom	Sum of Squares	Mean Sum of Squares	F	P
No. of Sounds	4	0.5581	0.1395	4.0691	0.0514
Residual	7	0.2400	0.0343		
Total	11	0.7981			

Table 18(b)

ANOVA of Difference Between Percent Highly Annoyed Based on Session Ratings and Percent Highly Annoyed Based on Average of Individual Ratings

Source	Degrees of Freedom	Sum of Squares	Mean Sum of Squares	F	P
No. of Sounds	4	235.94	58.98	2.03	NS
Residual	7	203.12	29.02		
Total	11	439.06			

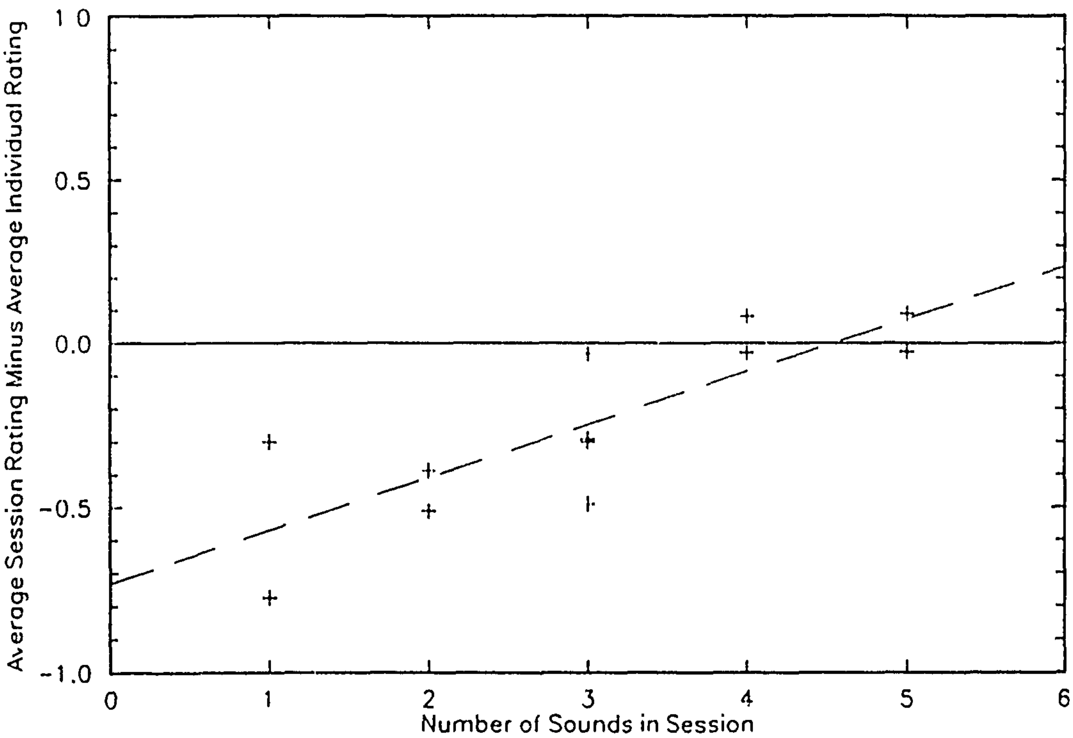

Figure 21. Average Session Rating Minus Average Individual Rating Versus Number of Sounds in Session.

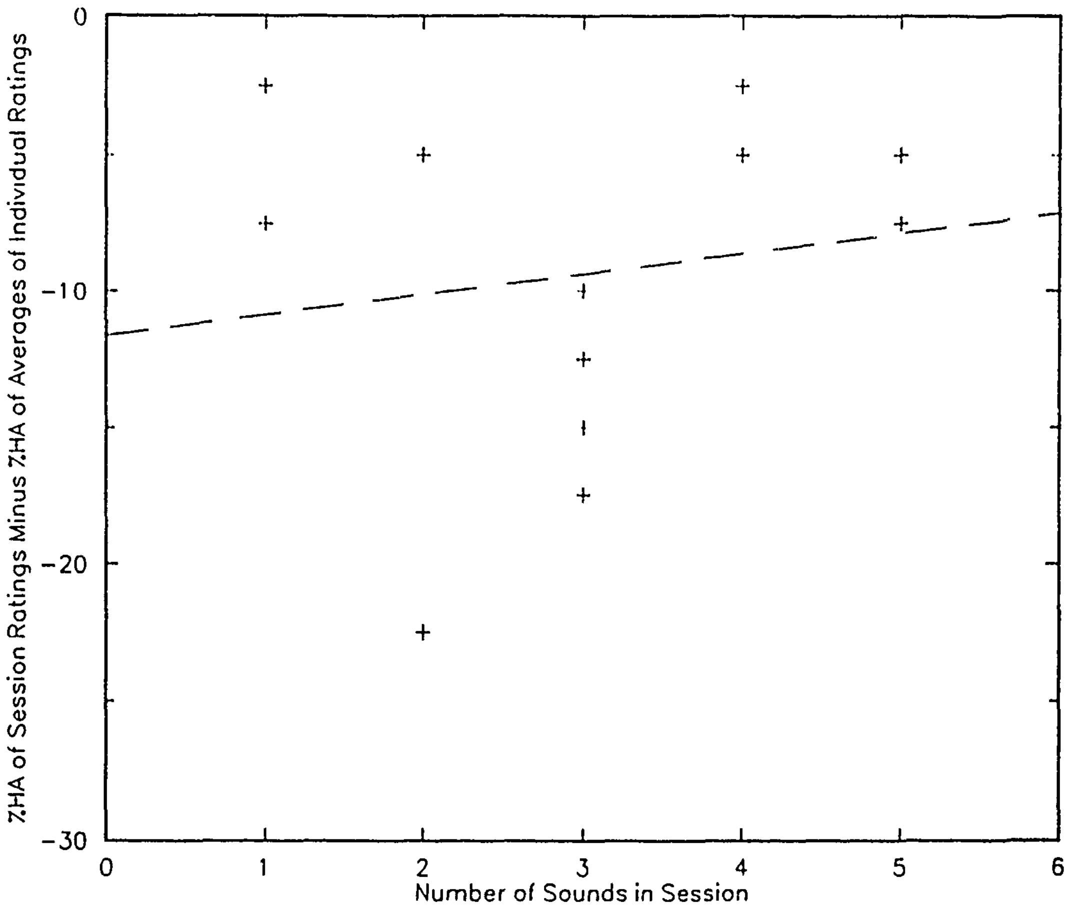

Figure 22. Percent Highly Annoyed Based on Session Ratings Minus Percent Highly Annoyed Based on Individual Ratings Versus Number of Sounds in Session.

6.0 CONCLUSIONS

The results of this study are similar to the results of the preceding laboratory study.[7] They confirm the appropriateness of an onset rate adjustment. The format of the adjustment is almost the same as that found in the laboratory study; only the onset rate at which the adjustment first becomes non-zero differs between the two experiments.

In addition, the study found no statistically significant dependence of the participants' responses on the activity in which they were engaged. The activities included in this study are typical of the more noise-sensitive indoor activities (i.e., watching television, reading, and concentrating on a task) that are normally undertaken.

The study also provides a preliminary indication that, when compared to the effects of sound level and onset rate, there is no statistically significant additional effect of the number of sound stimuli per hour on the average hourly responses of the participants. Thus any effects on annoyance of the infrequency of the noise events appears to be second-order. The responses to the Post-Experiment Questionnaire generally confirm these quantitative results.

Finally, the appropriateness of the use of the onset rate adjustment was further confirmed by the fact that the relation between the participants' hourly responses and the onset-rate-adjusted hourly equivalent sound level more closely matches the Schultz curve[1,2] than does the relation between the participants' hourly responses and the unadjusted hourly equivalent sound level.

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APPENDIX A

Percent Highly Annoyed as a Function of Unadjusted and Onset-Rate-Adjusted L_{dn}

This appendix contains details of the calculations used to compute for each hourly session the percent of respondents highly annoyed, the unadjusted L_{eq}, and the onset-rate-adjusted L_{eq}. (Since none of the data were acquired during night-time hours, hourly L_{eq} and L_{dn} are equivalent in this case.)

The Schultz curve does not relate L_{dn} to the average annoyance rating; rather it relates L_{dn} to the "percent highly annoyed". Table A1 shows the cumulative distribution of the session annoyance ratings for each of the 12 one-hour sessions for the outdoors/110 dB and the indoors/95 dB data.

If one uses the criterion developed by Schultz,[1] the percent highly annoyed may be identified with the cumulative percentage for the annoyance rating range from 6 to 8 rating points. This choice agrees well with the descriptors associated with these point values on the Annoyance Rating Response Form: 6 – highly annoyed, 7 – extremely annoyed.

The hourly L_{eq} for each of the 12 one-hour sessions is given in Table A2. This table shows the measured average SEL values and standard deviations for each of the sounds in each of the sessions. These are combined to provide the associated average L_{eq} and standard deviation for each session.

Table A3 provides similar data for the onset-rate-adjusted hourly L_{eq}. Each of the SEL values in Table A2 has been onset rate adjusted using the adjustment in Figure 16 of Section 5.1 (also Figure 1(c) of Section 1). The resultant SEL_r values are combined to provide the associated L_{eqr} and standard deviation for each session.

Table A4 is similar to Table A3 except that the onset rate adjustment from the Interim Metric (Figure 1(a) of Section 1) has been used to adjust each SEL.

Table A1

(a) Cumulative Hourly Rating Distribution – Outdoors/110 dB Data

Range	Session ID												AVG
	1	2	3	4	5	6	7	8	9	10	11	12	
8	0.0	30.0	5.0	0.0	0.0	5.0	5.0	0.0	5.0	5.0	0.0	0.0	4.6
7–8	30.0	45.0	25.0	5.0	10.0	20.0	25.0	20.0	20.0	15.0	15.0	5.0	19.6
6–8	70.0	75.0	55.0	35.0	40.0	40.0	55.0	65.0	45.0	55.0	50.0	35.0	51.7
5–8	85.0	85.0	75.0	60.0	55.0	70.0	80.0	80.0	50.0	70.0	65.0	65.0	70.0
4–8	85.0	85.0	90.0	75.0	70.0	85.0	85.0	90.0	60.0	80.0	90.0	80.0	81.3
3–8	90.0	90.0	95.0	85.0	80.0	90.0	90.0	95.0	80.0	95.0	95.0	95.0	90.0
2–8	95.0	95.0	95.0	100.0	90.0	100.0	90.0	100.0	90.0	95.0	100.0	100.0	95.8
1–8	100.0	95.0	95.0	100.0	95.0	100.0	95.0	100.0	100.0	100.0	100.0	100.0	98.3
0–8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

(b) Cumulative Hourly Rating Distribution – Indoors/95 dB Data

Range	Session ID												AVG
	1	2	3	4	5	6	7	8	9	10	11	12	
8	0.0	0.0	2.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
7–8	5.0	25.0	12.5	7.5	7.5	2.5	7.5	10.0	2.5	7.5	7.5	5.0	8.3
6–8	15.0	45.0	45.0	22.5	15.0	12.5	25.0	37.5	7.5	27.5	40.0	30.0	26.9
5–8	30.0	57.5	47.5	55.0	40.0	32.5	47.5	57.5	22.5	55.0	57.5	52.5	46.3
4–8	52.5	67.5	70.0	60.0	67.5	57.5	65.0	67.5	52.5	75.0	75.0	67.5	64.8
3–8	70.0	72.5	85.0	77.5	85.0	72.5	82.5	82.5	82.5	90.0	87.5	82.5	80.8
2–8	82.5	92.5	92.5	85.0	97.5	85.0	97.5	95.0	92.5	97.5	92.5	92.5	91.9
1–8	97.5	100.0	100.0	97.5	100.0	100.0	100.0	100.0	97.5	97.5	97.5	97.5	98.8
0–8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table A2(a)

Leq for Session Sounds Outdoors

Session ID	ID of Sounds		SEL of Sound No. 1	No. 2	No. 3	No. 4	No. 5	Leq
1	4	NO:	10.0					10.0
		AVG:	109.2					73.6
		STD:	1.1					1.1
2	6	NO:	10.0					10.0
		AVG:	105.9					70.3
		STD:	1.6					1.6
3	5, 6	NO:	10.0	10.0				20.0
		AVG:	108.1	106.4				74.8
		STD:	0.8	1.1				0.7
4	3, 5	NO:	10.0	10.0				20.0
		AVG:	109.8	108.1				76.5
		STD:	1.3	1.0				0.9
5	2, 3, 5	NO:	10.0	10.0	10.0			30.0
		AVG:	110.0	109.6	108.0			78.5
		STD:	1.2	0.9	1.1			0.6
6	1, 3, 2	NO:	10.0	10.0	10.0			30.0
		AVG:	111.4	109.6	109.9			79.6
		STD:	1.4	1.3	1.5			0.8
7	1, 6, 4	NO:	10.0	10.0	10.0			30.0
		AVG:	111.3	106.0	108.7			78.4
		STD:	0.9	1.3	1.7			0.7
8	6, 5, 4	NO:	10.0	10.0	10.0			30.0
		AVG:	106.2	108.2	109.1			77.2
		STD:	1.2	1.1	1.1			0.7
9	4, 1, 3, 2	NO:	10.0	10.0	10.0	10.0		40.0
		AVG:	108.9	111.2	109.7	110.0		80.5
		STD:	1.9	0.8	1.7	1.6		0.7
10	1, 2, 6, 4	NO:	10.0	10.0	10.0	10.0		40.0
		AVG:	111.3	109.7	106.0	108.9		79.8
		STD:	0.8	1.6	1.1	1.0		0.6
11	2, 3, 1, 6, 5	NO:	10.0	10.0	10.0	10.0	10.0	50.0
		AVG:	110.0	109.9	110.9	106.3	108.1	80.8
		STD:	1.1	0.9	1.0	1.1	0.8	0.5
12	5, 2, 1, 3, 4	NO:	10.0	10.0	10.0	10.0	10.0	50.0
		AVG:	107.9	109.6	111.1	109.6	108.6	80.9
		STD:	1.3	1.0	1.5	1.1	1.2	0.6

Table A2(b)

Leq for Session Sounds Indoors

Session ID	ID of Sounds		SEL of Sound No. 1	No. 2	No. 3	No. 4	No. 5	Leq
1	4	NO:	30					30
		AVG:	94.8					59.2
		STD:	0.5					0.5
2	6	NO:	30					30
		AVG:	94.6					59.0
		STD:	0.8					0.8
3	5, 6	NO:	30	30				60
		AVG:	95.0	94.4				62.2
		STD:	0.6	0.8				0.5
4	3, 5	NO:	30	30				60
		AVG:	94.6	95.1				62.3
		STD:	0.7	0.7				0.5
5	2, 3, 5	NO:	30	30	30			90
		AVG:	95.0	94.6	95.1			64.1
		STD:	0.5	0.9	0.6			0.4
6	1, 3, 2	NO:	30	30	30			90
		AVG:	97.3	94.5	94.7			64.9
		STD:	1.6	0.8	0.6			0.8
7	1, 6, 4	NO:	30	30	30			90
		AVG:	97.7	94.5	94.9			65.2
		STD:	1.6	0.8	0.6			0.8
8	6, 5, 4	NO:	30	30	30			90
		AVG:	94.3	94.9	94.7			63.8
		STD:	0.7	0.6	0.6			0.4
9	4, 1, 3, 2	NO:	29	30	30	30		119
		AVG:	94.9	97.3	94.7	94.9		66.1
		STD:	1.0	2.0	1.0	0.9		0.8
10	1, 2, 6, 4	NO:	29	29	29	29		116
		AVG:	97.2	94.8	94.4	94.5		65.8
		STD:	2.0	0.7	1.1	1.2		0.8
11	2, 3, 1, 6, 5	NO:	30	30	30	30	30	150
		AVG:	94.6	94.5	97.3	94.3	95.0	66.7
		STD:	1.0	0.8	1.9	0.9	0.8	0.7
12	5, 2, 1, 3, 4	NO:	29	29	29	29	29	145
		AVG:	95.1	94.9	97.3	94.6	94.9	66.9
		STD:	0.5	0.7	1.7	0.9	0.7	0.6

Table A3(a)

Leqr for Session Sounds Outdoors Using Onset-Rate Adjustment
From Rented Home Experiment (Figure 1(c))

Session ID	ID of Sounds		SELr of Sound					Leqr
			No. 1	No. 2	No. 3	No. 4	No. 5	
1	4	NO:	10.0					10.0
		AVG:	114.1					78.5
		STD:	1.1					1.1
2	6	NO:	10.0					10.0
		AVG:	116.9					81.3
		STD:	1.6					1.6
3	5, 6	NO:	10.0	10.0				20.0
		AVG:	115.3	117.4				83.9
		STD:	0.8	1.1				0.7
4	3, 5	NO:	10.0	10.0				20.0
		AVG:	111.6	115.3				81.3
		STD:	1.3	1.0				0.8
5	2, 3, 5	NO:	10.0	10.0	10.0			30.0
		AVG:	110.3	111.4	115.2			82.0
		STD:	1.2	0.9	1.1			0.7
6	1, 3, 2	NO:	10.0	10.0	10.0			30.0
		AVG:	111.4	111.4	110.2			80.2
		STD:	1.4	1.3	1.5			0.8
7	1, 6, 4	NO:	10.0	10.0	10.0			30.0
		AVG:	111.3	117.0	113.6			83.8
		STD:	0.9	1.3	1.7			0.9
8	6, 5, 4	NO:	10.0	10.0	10.0			30.0
		AVG:	117.2	115.4	114.0			84.9
		STD:	1.2	1.1	1.1			0.7
9	4, 1, 3, 2	NO:	10.0	10.0	10.0	10.0		40.0
		AVG:	113.8	111.2	111.5	110.3		82.4
		STD:	1.9	0.8	1.7	1.6		0.9
10	1, 2, 6, 4	NO:	10.0	10.0	10.0	10.0		40.0
		AVG:	111.3	110.0	117.0	113.8		84.3
		STD:	0.8	1.6	1.1	1.0		0.6
11	2, 3, 1, 6, 5	NO:	10.0	10.0	10.0	10.0	10.0	50.0
		AVG:	111.7	111.5	110.9	117.3	115.3	85.5
		STD:	1.1	0.9	1.0	1.1	0.8	0.5
12	5, 2, 1, 3, 4	NO:	10.0	10.0	10.0	10.0	10.0	50.0
		AVG:	115.1	109.9	111.1	111.4	113.5	84.0
		STD:	1.3	1.0	1.5	1.1	1.2	0.6

Table A3(b)

Leqr for Session Sounds Indoors Using Onset-Rate Adjustment
From Rented Home Experiment (Figure 1(c))

Session ID	ID of Sounds		SELr of Sound					Leqr
			No. 1	No. 2	No. 3	No. 4	No. 5	
1	4	NO:	30.0	0.0	0.0	0.0	0.0	30.0
		AVG:	99.7					64.1
		STD:	0.5					0.5
2	6	NO:	30.0					30.0
		AVG:	105.6					70.0
		STD:	0.8					0.8
3	5, 6	NO:	30.0	30.0				60.0
		AVG:	102.2	105.4				71.5
		STD:	0.6	0.8				0.6
4	3, 5	NO:	30.0	30.0				60.0
		AVG:	96.4	102.3				67.7
		STD:	0.7	0.7				0.6
5	2, 3, 5	NO:	30.0	30.0	30.0			90.0
		AVG:	95.3	96.4	102.3			68.4
		STD:	0.5	0.9	0.6			0.4
6	1, 3, 2	NO:	30.0	30.0	30.0			90.0
		AVG:	97.3	96.3	95.0			65.5
		STD:	1.6	0.8	0.6			0.7
7	1, 6, 4	NO:	30.0	30.0	30.0			90.0
		AVG:	97.7	105.5	99.8			71.5
		STD:	1.6	0.8	0.6			0.6
8	6, 5, 4	NO:	30.0	30.0	30.0			90.0
		[illegible]	105.3	102.1	99.6			72.2
		[illegible]	0.7	0.6	0.6			0.4
9	4, 1, 3, 2	[illegible]	29.0	30.0	30.0	30.0		119.0
		AVG:	99.8	97.3	96.5	95.2		68.0
		STD:	1.0	2.0	1.0	0.9		0.7
10	1, 2, 6, 4	NO:	29.0	29.0	29.0	29.0		116.0
		AVG:	97.2	95.1	105.4	99.4		71.6
		STD:	2.0	0.7	1.1	1.2		0.8
11	2, 3, 1, 6, 5	NO:	30.0	30.0	30.0	30.0	30.0	150.0
		AVG:	94.9	96.3	97.3	105.3	102.2	72.4
		STD:	1.0	0.8	1.9	0.9	0.8	0.6
12	5, 2, 1, 3, 4	NO:	29.0	29.0	29.0	29.0	29.0	145.0
		AVG:	102.3	95.2	97.3	96.4	99.8	70.4
		STD:	0.5	0.7	1.7	0.9	0.7	0.4

Table A4(a)

Leqr for Session Sounds Outdoors Using Onset-Rate Adjustment
In Interim Metric (Figure 1(a))

Session ID	ID of Sounds		SELr of Sound No. 1	No. 2	No. 3	No. 4	No. 5	Leqr
1	4	NO:	10.0					10.0
		AVG:	114.2					78.6
		STD:	1.1					1.1
2	6	NO:	10.0					10.0
		AVG:	110.9					75.3
		STD:	1.6					1.6
3	5, 6	NO:	10.0	10.0				20.0
		AVG:	113.1	111.4				79.8
		STD:	0.8	1.1				0.7
4	3, 5	NO:	10.0	10.0				20.0
		AVG:	112.6	113.1				80.3
		STD:	1.3	1.0				0.8
5	2, 3, 5	NO:	10.0	10.0	10.0			30.0
		AVG:	110.5	112.4	113.0			81.3
		STD:	1.2	0.9	1.1			0.6
6	1, 3, 2	NO:	10.0	10.0	10.0			30.0
		AVG:	111.4	112.4	110.4			80.7
		STD:	1.4	1.3	1.5			0.8
7	1, 6, 4	NO:	10.0	10.0	10.0			30.0
		AVG:	111.3	111.0	113.7			81.4
		STD:	0.9	1.3	1.7			0.9
8	6, 5, 4	NO:	10.0	10.0	10.0			30.0
		AVG:	111.2	113.2	114.1			82.2
		STD:	1.2	1.1	1.1			0.7
9	4, 1, 3, 2	NO:	10.0	10.0	10.0	10.0		40.0
		AVG:	113.9	111.2	112.5	110.5		82.7
		STD:	1.9	0.8	1.7	1.6		0.9
10	1, 2, 6, 4	NO:	10.0	10.0	10.0	10.0		40.0
		AVG:	111.3	110.2	111.0	113.9		82.3
		STD:	0.8	1.6	1.1	1.0		0.6
11	2, 3, 1, 6, 5	NO:	10.0	10.0	10.0	10.0	10.0	50.0
		AVG:	110.5	112.7	110.9	111.3	113.1	83.2
		STD:	1.1	0.9	1.0	1.1	0.8	0.4
12	5, 2, 1, 3, 4	NO:	10.0	10.0	10.0	10.0	10.0	50.0
		AVG:	112.9	110.1	111.1	111.4	113.6	83.4
		STD:	1.3	1.0	1.5	1.1	1.2	0.6

Table A4(b)

Leqr for Session Sounds Indoors Using Onset-Rate Adjustment in Interim Metric (Figure 1(a))

Session ID	ID of Sounds		SELr of Sound No. 1	No. 2	No. 3	No. 4	No. 5	Leqr
1	4	NO:	30.0	0.0	0.0	0.0	0.0	30.0
		AVG:	99.8					64.1
		STD:	0.5					0.5
2	6	NO:	30.0					30.0
		AVG:	99.6					64.0
		STD:	0.8					0.8
3	5, 6	NO:	30.0	30.0				60.0
		AVG:	100.0	99.4				67.2
		STD:	0.6	0.8				0.5
4	3, 5	NO:	30.0	30.0				60.0
		AVG:	97.4	100.1				66.4
		STD:	0.7	0.7				0.5
5	2, 3, 5	NO:	30.0	30.0	30.0			90.0
		AVG:	95.5	97.4	100.1			67.3
		STD:	0.5	0.9	0.6			0.4
6	1, 3, 2	NO:	30.0	30.0	30.0			90.0
		AVG:	97.3	97.3	95.2			65.9
		STD:	1.6	0.8	0.6			0.7
7	1, 6, 4	NO:	30.0	30.0	30.0			90.0
		AVG:	97.7	99.5	99.9			68.3
		STD:	1.6	0.8	0.6			0.5
8	6, 5, 4	NO:	30.0	30.0	30.0			90.0
		AVG:	99.3	99.9	99.7			68.8
		STD:	0.7	0.6	0.6			0.4
9	4, 1, 3, 2	NO:	29.0	30.0	30.0	30.0		119.0
		AVG:	99.9	97.3	97.5	95.4		68.3
		STD:	1.0	2.0	1.0	0.9		0.7
10	1, 2, 6, 4	NO:	29.0	29.0	29.0	29.0		116.0
		AVG:	97.2	95.3	99.4	99.5		68.6
		STD:	2.0	0.7	1.1	1.2		0.7
11	2, 3, 1, 6, 5	NO:	30.0	30.0	30.0	30.0	30.0	150.0
		AVG:	95.1	97.3	97.3	99.3	100.0	69.6
		STD:	1.0	0.8	1.9	0.9	0.8	0.5
12	5, 2, 1, 3, 4	NO:	29.0	29.0	29.0	29.0	29.0	145.0
		AVG:	100.1	95.4	97.3	97.4	99.9	69.8
		STD:	0.5	0.7	1.7	0.9	0.7	0.4

APPENDIX B

Comparison of Individual Stimulus Responses in Each Session with Session Responses for Indoors/95 dB Data Set

This appendix contains, for each of the 12 hourly sessions, the averages of the individual ratings for each indoors/95 dL)und presented to each participant, the session rating for each participant, and .he corresponding difference between the two. It also contains, for each of the 12 hourly sessions, the percent highly annoyed based on the averages of the individual ratings and the percent highly annoyed based on the session ratings. As in Appendix A, the percent highly annoyed is identified with the cumulative percentage for the annoyance rating range from 6 to 8 rating points.

In each table, the first column is the identification number for the participant. The next several columns, ranging from one to five in number, are the individual ratings for each of the sounds presented in the session. The sound identifiers, S1 to S6, at the head of each column correspond to the sounds listed in Table 6 in Section 4.3. The next column, labeled "AVG", is the numerical average of the individual ratings presented in the previous columns.

Following this column is a column giving the session rating for each participant. This is followed by a column giving the differences between the session ratings and the average of individual ratings.

At the bottom of each of these columns are listed the number of participants (No), the average over all participants (Avg), and the corresponding standard deviation (Std).

To the right of the columns described above are two distributions – one of the averages of the individual ratings, the other of the session ratings. In each distribution, the first column gives the rating number bin, the second column gives the number of responses in this bin, the third column gives the percent of responses in the bin, and the fourth column gives the cumulative percent response (summing from the highest rating down). The cumulative percent corresponding to the sum of ratings 6, 7, and 8 is identified as the percent highly annoyed (%HA).

Table B1

Ratings for Session 1 (One Plane)

I.D.	Individual Ratings		Sess. Rating	S-I
	S4	AVG		
1	3	3.00	3	0.00
2	4	4.00	4	0.00
3	5	5.00	5	0.00
6	3	3.00	1	-2.00
10	3	3.00	3	0.00
14	4	4.00	1	-3.00
17	3	3.00	3	0.00
18	3	3.00	3	0.00
20	3	3.00	4	1.00
22	5	5.00	5	0.00
23	4	4.00	4	0.00
24	5	5.00	4	-1.00
25	2	2.00	2	0.00
27	4	4.00	4	0.00
28	2	2.00	1	-1.00
32	1	1.00	1	0.00
33	4	4.00	4	0.00
34	7	7.00	7	0.00
35	6	6.00	6	0.00
37	3	3.00	2	-1.00
38	2	2.00	2	0.00
40	6	6.00	4	-2.00
41	5	5.00	5	0.00
42	3	3.00	3	0.00
44	3	3.00	3	0.00
46	6	6.00	6	0.00
48	3	3.00	2	-1.00
50	0	0.00	0	0.00
51	2	2.00	1	-1.00
53	4	4.00	4	0.00
55	3	3.00	3	0.00
59	1	1.00	1	0.00
61	4	4.00	4	0.00
63	6	6.00	6	0.00
64	5	5.00	5	0.00
65	7	7.00	6	-1.00
67	5	5.00	5	0.00
68	7	7.00	7	0.00
69	5	5.00	5	0.00
70	2	2.00	2	0.00
No	40	40	40	40
Avg	3.83	3.83	3.53	-0.30
Std	1.69	1.69	1.79	0.71

Rating	Distribution of Average Ratings			
	N	%	Σ%	
0	1	2.50	100.00	
1	2	5.00	97.50	
2	5	12.50	92.50	
3	11	27.50	80.00	
4	7	17.50	52.50	
5	7	17.50	35.00	
6	4	10.00	17.50	<%HA
7	3	7.50	7.50	
8	0	0.00	0.00	
Total	40	100.00		

Rating	Distribution of Session Ratings			
	N	%	Σ%	
0	1	2.50	100.00	
1	6	15.00	97.50	
2	5	12.50	82.50	
3	7	17.50	70.00	
4	9	22.50	52.50	
5	6	15.00	30.00	
6	4	10.00	15.00	<%HA
7	2	5.00	5.00	
8	0	0.00	0.00	
Total	40	100.00		

Table B2

Ratings for Session 2 (One Plane)

I.D.	Individual Ratings S6	Individual Ratings AVG	Sess. Rating	S-I
1	7	7.00	6	-1.00
2	5	5.00	5	0.00
9	6	6.00	6	0.00
10	6	6.00	6	0.00
13	5	5.00	5	0.00
14	5	5.00	2	-3.00
15	2	2.00	2	0.00
17	5	5.00	5	0.00
18	7	7.00	7	0.00
19	6	6.00	6	0.00
20	7	7.00	6	-1.00
22	6	6.00	6	0.00
24	7	7.00	6	-1.00
25	4	4.00	4	0.00
27	4	4.00	4	0.00
30	6	6.00	7	1.00
32	1	1.00	1	0.00
33	3	3.00	3	0.00
36	2	2.00	1	-1.00
37	3	3.00	2	-1.00
38	3	3.00	3	0.00
40	7	7.00	2	-5.00
41	8	8.00	7	-1.00
44	5	5.00	2	-3.00
45	5	5.00	5	0.00
46	5	5.00	5	0.00
48	4	4.00	1	-3.00
49	7	7.00	7	0.00
51	4	4.00	2	-2.00
53	4	4.00	4	0.00
55	7	7.00	2	-5.00
56	7	7.00	7	0.00
61	6	6.00	6	0.00
64	7	7.00	7	0.00
65	7	7.00	2	-5.00
66	7	7.00	7	0.00
67	7	7.00	7	0.00
69	7	7.00	7	0.00
70	4	4.00	4	0.00
71	7	7.00	7	0.00
No	40	40	40	40
Avg	5.38	5.38	4.60	-0.78
Std	1.71	1.73	2.11	1.51

Rating	Distribution of Average Ratings N	%	Σ%
0	0	0.00	100.00
1	1	2.50	100.00
2	2	5.00	97.50
3	3	7.50	92.50
4	6	15.00	85.00
5	7	17.50	70.00
6	6	15.00	52.50 <%HA
7	14	35.00	37.50
8	1	2.50	2.50
Total	40	100.00	

Rating	Distribution of Session Ratings N	%	Σ%
0	0	0.00	100.00
1	3	7.50	100.00
2	8	20.00	92.50
3	2	5.00	72.50
4	4	10.00	67.50
5	5	12.50	57.50
6	8	20.00	45.00 <%HA
7	10	25.00	25.00
8	0	0.00	0.00
Total	40	100.00	

Table B3

Ratings for Session 3 (Two Planes)

I.D.	Individual Ratings S5	S6	AVG	Sess. Rating	S-I
1	3	7	5.00	4	-1.00
6	4	6	5.00	3	-2.00
8	8	8	8.00	7	-1.00
9	5	6	5.50	6	0.50
10	2	6	4.00	3	-1.00
13	4	5	4.50	3	-1.50
15	1	2	1.50	1	-0.50
16	6	6	6.00	6	0.00
17	5	4	4.50	4	-0.50
18	7	6	6.50	6	-0.50
19	6	7	6.50	6	-0.50
20	6	7	6.50	6	-0.50
21	6	7	6.50	6	-0.50
23	6	7	6.50	6	-0.50
27	2	6	4.00	3	-1.00
28	3	5	4.00	4	0.00
30	5	7	6.00	6	0.00
32	1	1	1.00	1	0.00
33	3	4	3.50	3	-0.50
35	6	6	6.00	6	0.00
36	1	3	2.00	1	-1.00
37	2	2	2.00	2	0.00
38	4	5	4.50	4	-0.50
39	4	5	4.50	4	-0.50
42	3	4	3.50	4	0.50
45	5	6	5.50	6	0.50
46	4	5	4.50	4	-0.50
47	3	5	4.00	4	0.00
49	3	4	3.50	3	-0.50
51	2	3	2.50	2	-0.50
53	4	5	4.50	4	-0.50
55	4	7	5.50	2	-3.50
56	6	7	6.50	6	-0.50
63	6	7	6.50	7	0.50
64	5	7	6.00	6	0.00
65	7	8	7.50	6	-1.50
66	7	7	7.00	7	0.00
68	8	8	8.00	8	0.00
71	5	8	6.50	5	-1.50
72	7	7	7.00	7	0.00
No	40	40	40	40	40
Avg	4.48	5.65	5.06	4.55	-0.51
Std	1.91	1.74	1.73	1.86	0.75

Rating	Distribution of Average Ratings N	%	Σ%
0	0	0.00	100.00
1	1	2.50	100.00
2	3	7.50	97.50
3	1	2.50	90.00
4	7	17.50	87.50
5	8	20.00	70.00
6	7	17.50	50.00 <%HA
7	10	25.00	32.50
8	3	7.50	7.50
Total	40	100.00	

Rating	Distribution of Session Ratings N	%	Σ%
0	0	0.00	100.00
1	3	7.50	100.00
2	3	7.50	92.50
3	6	15.00	85.00
4	9	22.50	70.00
5	1	2.50	47.50
6	13	32.50	45.00 <%HA
7	4	10.00	12.50
8	1	2.50	2.50
Total	40	100.00	

Table B4

Ratings for Session 4 (Two Planes)

I.D.	Individual Ratings S5	S3	AVG	Sess. Rating	S-I
1	3	3	3.00	3	0.00
3	6	5	5.50	5	-0.50
6	3	4	3.50	3	-0.50
8	8	8	8.00	8	0.00
9	5	4	4.50	4	-0.50
11	7	6	6.50	7	0.50
15	2	2	2.00	2	0.00
16	6	4	5.00	5	0.00
17	6	5	5.50	3	-2.50
19	6	6	6.00	6	0.00
20	5	5	5.00	5	0.00
21	5	6	5.50	5	-0.50
22	7	6	6.50	6	-0.50
23	6	4	5.00	5	0.00
27	1	1	1.00	1	0.00
28	3	4	3.50	3	-0.50
32	1	1	1.00	1	0.00
33	3	2	2.50	2	-0.50
34	7	6	6.50	7	0.50
36	1	3	2.00	1	-1.00
38	4	2	3.00	3	0.00
39	5	3	4.00	4	0.00
40	6	7	6.50	6	-0.50
41	5	4	4.50	5	0.50
42	2	2	2.00	2	0.00
45	5	7	6.00	6	0.00
46	6	5	5.50	5	-0.50
47	6	5	5.50	5	-0.50
48	3	1	2.00	1	-1.00
50	0	0	0.00	0	0.00
54	6	4	5.00	5	0.00
55	6	5	5.50	1	-4.50
59	3	2	2.50	3	0.50
65	7	6	6.50	5	-1.50
66	7	3	5.00	5	0.00
67	3	4	3.50	3	-0.50
68	6	5	5.50	5	-0.50
69	6	6	6.00	6	0.00
71	7	6	6.50	6	-0.50
72	6	5	5.50	5	-0.50
No	40	40	40	40	40
Avg	4.75	4.18	4.46	4.08	-0.39
Std	2.02	1.87	1.86	1.94	0.86

Rating	Distribution of Average Ratings N	%	Σ%
0	1	2.50	100.00
1	2	5.00	97.50
2	4	10.00	92.50
3	4	10.00	82.50
4	4	10.00	72.50
5	7	17.50	62.50
6	11	27.50	45.00 <%HA
7	6	15.00	17.50
8	1	2.50	2.50
Total	40	100.00	

Rating	Distribution of Session Ratings N	%	Σ%
0	1	2.50	100.00
1	5	12.50	97.50
2	3	7.50	85.00
3	7	17.50	77.50
4	2	5.00	60.00
5	13	32.50	55.00
6	6	15.00	22.50 <%HA
7	2	5.00	7.50
8	1	2.50	2.50
Total	40	100.00	

Table B5

Ratings for Session 5 (Three Planes)

I.D.	Individual Ratings S2	S5	S3	AVG	Sess. Rating	S-I
2	4	5	5	4.67	4	-0.67
3	4	6	5	5.00	5	0.00
8	7	8	5	6.67	5	-1.67
9	5	4	5	4.67	5	0.33
10	2	3	5	3.33	3	-0.33
11	4	7	5	5.33	5	-0.33
13	2	5	5	4.00	4	0.00
14	3	5	5	4.33	3	-1.33
16	3	5	5	4.33	4	-0.33
18	2	3	5	3.33	2	-1.33
21	6	7	5	6.00	7	1.00
23	4	5	5	4.67	4	-0.67
24	5	6	5	5.33	5	-0.33
25	2	3	5	3.33	2	-1.33
27	1	4	5	3.33	1	-2.33
28	2	1	5	2.67	2	-0.67
30	5	6	5	5.33	6	0.67
31	3	4	5	4.00	3	-1.00
34	6	7	5	6.00	7	1.00
35	4	6	5	5.00	4	-1.00
39	3	6	5	4.67	4	-0.67
40	5	7	5	5.67	6	0.33
41	5	6	5	5.33	5	-0.33
44	4	6	5	5.00	5	0.00
45	4	5	5	4.67	4	-0.67
46	4	6	5	5.00	5	0.00
47	3	5	5	4.33	4	-0.33
48	2	3	5	3.33	3	-0.33
49	3	3	5	3.67	3	-0.67
51	2	3	5	3.33	2	-1.33
53	2	4	5	3.67	3	-0.67
54	3	7	5	5.00	4	-1.00
59	2	2	5	3.00	2	-1.00
61	3	6	5	4.67	4	-0.67
66	6	7	5	6.00	6	0.00
67	4	5	5	4.67	4	-0.67
68	5	7	5	5.67	5	-0.67
69	8	7	5	6.67	7	0.33
70	3	3	5	3.67	3	-0.67
72	5	6	5	5.33	5	-0.33
No	40	40	40	40	40	40
Avg	3.75	5.10	5.00	4.62	4.13	-0.49
Std	1.55	1.64	0.00	1.00	1.45	0.67

Rating	Distribution of Average Ratings N	%	Σ%
0	0	0.00	100.00
1	0	0.00	100.00
2	0	0.00	100.00
3	2	5.00	100.00
4	11	27.50	95.00
5	15	37.50	67.50
6	10	25.00	30.00 <%HA
7	2	5.00	5.00
8	0	0.00	0.00
Total	40	100.00	

Rating	Distribution of Session Ratings N	%	Σ%
0	0	0.00	100.00
1	1	2.50	100.00
2	5	12.50	97.50
3	7	17.50	85.00
4	11	27.50	67.50
5	10	25.00	40.00
6	3	7.50	15.00 <%HA
7	3	7.50	7.50
8	0	0.00	0.00
Total	40	100.00	

Table B6

Ratings for Session 6 (Three Planes)

I.D.	Individual Ratings S2	S1	S3	AVG	Sess. Rating	S-I
1	3	6	3	4.00	4	0.00
2	4	7	5	5.33	5	-0.33
3	6	4	7	5.67	5	-0.67
6	4	4	4	4.00	4	0.00
9	5	4	4	4.33	4	-0.33
14	2	2	3	2.33	2	-0.33
15	1	2	2	1.67	2	0.33
16	4	2	5	3.67	3	-0.67
17	4	4	3	3.67	4	0.33
19	6	3	4	4.33	5	0.67
20	3	3	2	2.67	4	1.33
22	5	6	5	5.33	5	-0.33
23	4	5	4	4.33	4	-0.33
24	5	5	6	5.33	5	-0.33
25	1	1	2	1.33	1	-0.33
27	1	1	4	2.00	3	1.00
31	3	1	3	2.33	2	-0.33
32	1	2	1	1.33	1	-0.33
34	6	5	7	6.00	6	0.00
36	2	1	1	1.33	1	-0.33
38	4	6	5	5.00	5	0.00
40	7	6	6	6.33	6	-0.33
41	5	6	5	5.33	4	-1.33
42	1	1	1	1.00	1	0.00
44	4	4	3	3.67	4	0.33
45	3	3	4	3.33	3	-0.33
48	2	1	1	1.33	1	-0.33
50	4	5	4	4.33	4	-0.33
51	2	2	2	2.00	2	0.00
53	2	3	2	2.33	2	-0.33
54	6	2	3	3.67	5	1.33
55	2	1	2	1.67	1	-0.67
56	3	4	5	4.00	4	0.00
61	4	1	2	2.33	3	0.67
63	6	7	7	6.67	7	0.33
67	4	2	4	3.33	3	-0.33
68	6	6	7	6.33	6	-0.33
69	6	5	3	4.67	6	1.33
70	2	2	4	2.67	3	0.33
72	5	5	6	5.33	5	-0.33
No	40	40	40	40	40	40
Avg	3.70	3.50	3.78	3.66	3.63	-0.03
Std	1.71	1.91	1.75	1.61	1.64	0.57

Rating	Distribution of Average Ratings N	%	Σ%
0	0	0.00	100.00
1	1	2.50	100.00
2	8	20.00	97.50
3	6	15.00	77.50
4	9	22.50	62.50
5	6	15.00	40.00
6	7	17.50	25.00 <%HA
7	3	7.50	7.50
8	0	0.00	0.00
Total	40	100.00	

Rating	Distribution of Session Ratings N	%	Σ%
0	0	0.00	100.00
1	6	15.00	100.00
2	5	12.50	85.00
3	6	15.00	72.50
4	10	25.00	57.50
5	8	20.00	32.50
6	4	10.00	12.50 <%HA
7	1	2.50	2.50
8	0	0.00	0.00
Total	40	100.00	

Table B7

Ratings for Session 7 (Three Planes)

I.D.	Individual Ratings S4	S1	S6	AVG	Sess. Rating	S-1
2	4	8	5	5.67	6	0.33
8	7	6	8	7.00	4	-3.00
9	6	4	7	5.67	6	0.33
10	4	1	6	3.67	3	-0.67
11	7	4	6	5.67	7	1.33
13	5	4	6	5.00	5	0.00
14	4	3	6	4.33	4	-0.33
15	2	3	4	3.00	3	0.00
16	5	3	6	4.67	4	-0.67
17	3	2	5	3.33	3	-0.33
19	5	4	7	5.33	4	-1.33
20	6	4	7	5.67	6	0.33
22	5	4	7	5.33	5	-0.33
24	5	4	7	5.33	5	-0.33
25	2	1	6	3.00	3	0.00
31	3	2	6	3.67	3	-0.67
33	3	2	4	3.00	3	0.00
34	6	6	7	6.33	6	-0.33
35	6	6	6	6.00	6	0.00
36	7	0	2	3.00	1	-2.00
37	3	2	3	2.67	2	-0.67
38	2	3	2	2.33	2	-0.33
39	6	5	5	5.33	5	-0.33
41	6	5	6	5.67	5	-0.67
45	5	4	6	5.00	5	0.00
47	4	4	5	4.33	4	-0.33
48	1	2	2	1.67	2	0.33
49	4	4	5	4.33	4	-0.33
51	2	2	3	2.33	2	-0.33
54	6	2	7	5.00	5	0.00
55	4	1	4	3.00	2	-1.00
56	5	4	7	5.33	5	-0.33
59	2	2	2	2.00	2	0.00
61	4	2	5	3.67	4	0.33
63	7	6	7	6.67	7	0.33
64	5	2	6	4.33	5	0.67
68	7	7	8	7.33	6	-1.33
69	7	6	8	7.00	7	0.00
70	3	2	6	3.67	3	-0.67
72	6	4	6	5.33	6	0.67
No	40	40	40	40	40	40
Avg	4.60	3.50	5.53	4.54	4.25	-0.29
Std	1.69	1.79	1.67	1.46	1.59	0.73

Rating	Distribution of Average Ratings N	%	Σ%
0	0	0.00	100.00
1	0	0.00	100.00
2	2	5.00	100.00
3	8	20.00	95.00
4	5	12.50	75.00
5	8	20.00	62.50
6	12	30.00	42.50 <%HA
7	4	10.00	12.50
8	1	2.50	2.50
Total	40	100.00	

Rating	Distribution of Session Ratings N	%	Σ%
0	0	0.00	100.00
1	1	2.50	100.00
2	6	15.00	97.50
3	7	17.50	82.50
4	7	17.50	65.00
5	9	22.50	47.50
6	7	17.50	25.00 <%HA
7	3	7.50	7.50
8	0	0.00	0.00
Total	40	100.00	

Table B8

Ratings for Session 8 (Three Planes)

I.D.	Individual Ratings S4	S5	S6	AVG	Sess. Rating	S-I
1	7	6	7	6.67	6	-0.67
3	6	6	7	6.33	6	-0.33
8	6	7	8	7.00	5	-2.00
9	5	4	5	4.67	5	0.33
10	3	6	6	5.00	5	0.00
11	6	6	7	6.33	7	0.67
14	2	3	5	3.33	2	-1.33
16	2	3	4	3.00	3	0.00
19	4	5	6	5.00	5	0.00
20	4	6	6	5.33	5	-0.33
21	8	7	7	7.33	7	-0.33
23	4	6	7	5.67	6	0.33
24	7	7	7	7.00	7	0.00
25	5	4	4	4.33	4	-0.33
28	3	4	6	4.33	5	0.67
30	6	6	7	6.33	6	-0.33
31	4	4	5	4.33	4	-0.33
32	1	1	2	1.33	2	0.67
33	3	3	3	3.00	3	0.00
35	6	6	6	6.00	6	0.00
36	2	2	4	2.67	2	-0.67
37	3	3	3	3.00	3	0.00
38	3	1	2	2.00	2	0.00
39	5	5	4	4.67	4	-0.67
44	4	4	6	4.67	4	-0.67
45	6	6	5	5.67	6	0.33
46	4	6	5	5.00	4	-1.00
49	4	5	7	5.33	5	-0.33
50	2	0	1	1.00	1	0.00
51	4	4	6	4.67	3	-1.67
53	2	2	2	2.00	2	0.00
56	4	6	7	5.67	5	-0.67
59	2	3	4	3.00	2	-1.00
61	4	4	5	4.33	4	-0.33
63	6	6	7	6.33	6	-0.33
64	5	4	7	5.33	6	0.67
67	5	5	6	5.33	5	-0.33
68	4	5	8	5.67	5	-0.67
69	6	7	8	7.00	6	-1.00
71	6	6	7	6.33	6	-0.33
No	40	40	40	40	40	40
Avg	4.33	4.60	5.48	4.80	4.50	-0.30
Std	1.65	1.77	1.80	1.62	1.61	0.59

Rating	Distribution of Average Ratings N	%	Σ%	
0	0	0.00	100.00	
1	1	2.50	100.00	
2	3	7.50	97.50	
3	5	12.50	90.00	
4	1	2.50	77.50	
5	11	27.50	75.00	
6	9	22.50	47.50	<%HA
7	9	22.50	25.00	
8	1	2.50	2.50	
Total	40	100.00		

Rating	Distribution of Session Ratings N	%	Σ%	
0	0	0.00	100.00	
1	2	5.00	100.00	
2	5	12.50	95.00	
3	6	15.00	82.50	
4	4	10.00	67.50	
5	8	20.00	57.50	
6	11	27.50	37.50	<%HA
7	4	10.00	10.00	
8	0	0.00	0.00	
Total	40	100.00		

Table B9

Ratings for Session 9 (Four Planes)

I.D.	Individual Ratings S2	S4	S1	S3	AVG	Sess. Rating	S-I
1	6	3	6	3	4.50	3	-1.50
3	4	6	3	6	4.75	5	0.25
6	6	5	5	6	5.50	5	-0.50
9	5	5	4	6	5.00	5	0.00
11	7	6	4	5	5.50	6	0.50
13	4	3	4	2	3.25	4	0.75
15	2	2	1	3	2.00	2	0.00
16	2	3	2	3	2.50	3	0.50
17	5	3	5	4	4.25	4	-0.25
18	3	3	2	3	2.75	3	0.25
19	3	5	4	5	4.25	4	-0.25
20	4	6	4	3	4.25	4	-0.25
21	3	4	5	4	4.00	4	0.00
22	4	6	3	4	4.25	4	-0.25
28	2	2	4	3	2.75	3	0.25
30	5	6	4	5	5.00	5	0.00
31	3	4	1	3	2.75	3	0.25
33	2	3	2	2	2.25	2	-0.25
34	7	7	6	6	6.50	7	0.50
35	6	4	4	4	4.50	5	0.50
37	2	2	2	2	2.00	2	0.00
39	5	3	4	4	4.00	4	0.00
40	6	7	6	6	6.25	6	-0.25
42	3	3	2	3	2.75	3	0.25
44	4	3	4	3	3.50	3	-0.50
47	3	4	3	3	3.25	3	-0.25
48	4	4	2	2	3.00	3	0.00
49	2	3	4	2	2.75	3	0.25
50	0	0	0	0	0.00	0	0.00
54	3	5	2	2	3.00	3	0.00
55	3	3	1	2	2.25	1	-1.25
56	4	5	3	4	4.00	4	0.00
59	2	3	2	2	2.25	2	-0.25
63	5	5	6	5	5.25	5	-0.25
64	4	3	3	4	3.50	4	0.50
65	5	5	4	5	4.75	4	-0.75
66	4	4	2	3	3.25	4	0.75
67	2	5	1	3	2.75	3	0.25
70	1	1	1	2	1.25	1	-0.25
71	4	4	4	4	4.00	4	0.00
No	40	40	40	40	40	40	40
Avg	3.73	3.95	3.23	3.53	3.61	3.58	-0.03
Std	1.60	1.55	1.56	1.41	1.34	1.39	0.45

Rating	Distribution of Average Ratings N	%	Σ%
0	1	2.50	100.00
1	0	0.00	97.50
2	3	7.50	97.50
3	12	30.00	90.00
4	9	22.50	60.00
5	10	25.00	37.50
6	3	7.50	12.50 <%HA
7	2	5.00	5.00
8	0	0.00	0.00
Total	40	100.00	

Rating	Distribution of Session Ratings N	%	Σ%
0	1	2.50	100.00
1	2	5.00	97.50
2	4	10.00	92.50
3	12	30.00	82.50
4	12	30.00	52.50
5	6	15.00	22.50
6	2	5.00	7.50 <%HA
7	1	2.50	2.50
8	0	0.00	0.00
Total	40	100.00	

Table B10

Ratings for Session 10 (Four Planes)

I.D.	Individual Ratings S2	S4	S1	S6	AVG	Sess. Rating	S-1
2	5	5	4	6	5.00	6	1.00
6	7	5	7	5	6.00	6	0.00
8	1	6	5	8	5.00	6	1.00
10	3	4	2	4	3.25	4	0.75
11	6	6	5	7	6.00	7	1.00
13	4	4	2	5	3.75	4	0.25
15	3	3	3	3	3.00	3	0.00
16	4	5	3	6	4.50	5	0.50
17	4	5	3	7	4.75	4	-0.75
18	3	5	4	6	4.50	5	0.50
19	4	6	5	6	5.25	5	-0.25
21	5	7	4	7	5.75	6	0.25
23	5	5	4	6	5.00	5	0.00
24	5	6	4	7	5.50	6	0.50
28	3	4	4	6	4.25	4	-0.25
30	5	6	4	7	5.50	6	0.50
31	2	3	1	6	3.00	3	0.00
33	3	3	3	4	3.25	3	-0.25
35	4	4	6	6	5.00	5	0.00
36	1	2	0	4	1.75	2	0.25
37	2	2	3	3	2.50	2	-0.50
38	3	4	3	6	4.00	4	0.00
41	4	6	4	6	5.00	5	0.00
42	4	4	4	6	4.50	4	-0.50
44	4	5	6	6	5.25	5	-0.25
46	5	6	4	7	5.50	5	-0.50
47	4	5	4	6	4.75	5	0.25
49	3	4	2	4	3.25	4	0.75
50	0	0	0	0	0.00	0	0.00
51	2	3	2	3	2.50	2	-0.50
54	4	4	2	7	4.25	3	-1.25
55	3	5	2	7	4.25	3	-1.25
59	3	4	2	4	3.25	4	0.75
63	6	7	7	7	6.75	7	0.25
64	4	5	4	6	4.75	5	0.25
65	5	6	4	7	5.50	6	0.50
66	6	6	7	8	6.75	7	0.25
70	2	3	2	5	3.00	3	0.00
71	5	7	5	7	6.00	6	0.00
72	4	5	4	7	5.00	5	0.00
No	40	40	40	40	40	40	40
Avg	3.75	4.63	3.60	5.70	4.42	4.50	0.08
Std	1.46	1.48	1.67	1.60	1.37	1.53	0.53

Rating	Distribution of Average Ratings N	%	Σ%
0	1	2.50	100.00
1	0	0.00	97.50
2	1	2.50	97.50
3	5	12.50	95.00
4	6	15.00	82.50
5	15	37.50	67.50
6	10	25.00	30.00 <%HA
7	2	5.00	5.00
8	0	0.00	0.00
Total	40	100.00	

Rating	Distribution of Session Ratings N	%	Σ%
0	1	2.50	100.00
1	0	0.00	97.50
2	3	7.50	97.50
3	6	15.00	90.00
4	8	20.00	75.00
5	11	27.50	55.00
6	8	20.00	27.50 <%HA
7	3	7.50	7.50
8	0	0.00	0.00
Total	40	100.00	

Table B11

Ratings for Session 11 (Five Planes)

I.D.	Individual Ratings S2	S1	S5	S3	S6	AVG	Sess. Rating	S-I
1	3	7	6	6	8	6.00	6	0.00
2	5	8	5	4	5	5.40	6	0.60
3	5	4	5	5	7	5.20	5	-0.20
6	5	7	5	5	4	5.20	5	-0.20
8	6	5	8	7	8	6.80	6	-0.80
11	7	4	7	6	6	6.00	6	0.00
13	4	2	5	4	5	4.00	4	0.00
14	3	4	5	4	7	4.60	4	-0.60
18	3	4	7	3	7	4.80	5	0.20
21	4	8	7	5	8	6.40	6	-0.40
22	4	6	6	4	7	5.40	6	0.60
24	5	7	7	6	8	6.60	7	0.40
25	1	1	3	2	5	2.40	3	0.60
27	1	1	2	2	6	2.40	3	0.60
28	2	3	2	2	6	3.00	4	1.00
30	6	5	6	6	7	6.00	6	0.00
31	3	1	4	4	6	3.60	4	0.40
32	1	1	1	1	2	1.20	1	-0.20
34	6	5	7	7	8	6.60	7	0.40
35	4	4	6	4	6	4.80	5	0.20
37	2	3	3	2	3	2.60	2	-0.60
39	7	5	4	4	5	5.00	5	0.00
40	7	5	7	6	7	6.40	6	-0.40
42	1	1	2	1	2	1.40	1	-0.40
44	3	5	2	2	6	3.60	4	0.40
47	4	4	5	5	6	4.80	5	0.20
48	2	1	3	2	3	2.20	2	-0.20
50	0	0	0	0	1	0.20	0	-0.20
53	1	3	3	1	5	2.60	3	0.40
54	2	4	6	4	7	4.60	4	-0.60
56	4	4	6	3	7	4.80	5	0.20
59	2	1	3	2	5	2.60	3	0.40
61	3	2	6	4	5	4.00	4	0.00
63	6	7	6	7	7	6.60	7	0.40
64	5	6	5	5	7	5.60	6	0.40
65	5	6	7	6	7	6.20	6	-0.20
66	4	3	8	4	8	5.40	6	0.60
70	2	2	4	2	6	3.20	3	-0.20
71	5	4	7	5	7	5.60	6	0.40
72	5	4	6	6	7	5.60	6	0.40
No	40	40	40	40	40	40	40	40
Avg	3.70	3.93	4.93	3.95	5.93	4.49	4.58	0.09
Std	1.86	2.13	1.99	1.86	1.75	1.68	1.73	0.41

Rating	Distribution of Average Ratings N	%	Σ%
0	0	0.00	100.00
1	1	2.50	100.00
2	2	5.00	97.50
3	7	17.50	92.50
4	5	12.50	75.00
5	7	17.50	62.50
6	11	27.50	45.00 <%HA
7	7	17.50	17.50
8	0	0.00	0.00
Total	40	100.00	

Rating	Distribution of Session Ratings N	%	Σ%
0	1	2.50	100.00
1	2	5.00	97.50
2	2	5.00	92.50
3	5	12.50	87.50
4	7	17.50	75.00
5	7	17.50	57.50
6	13	32.50	40.00 <%HA
7	3	7.50	7.50
8	0	0.00	0.00
Total	40	100.00	

Table B12

Ratings for Session 12 (Five Planes)

I.D.	Individual Ratings S2	S4	S1	S5	S3	AVG	Sess. Rating	S-1
2	4	4	6	4	4	4.40	4	-0.40
3	6	5	4	5	4	4.80	5	0.20
6	4	4	6	4	5	4.60	4	-0.60
8	8	-	7	7	8	7.50	7	-0.50
10	3	4	1	3	3	2.80	3	0.20
11	7	5	5	6	6	5.80	6	0.20
13	5	4	4	6	4	4.60	4	-0.60
14	1	4	2	3	2	2.40	3	0.60
15	2	3	2	2	2	2.20	2	-0.20
18	3	5	5	5	4	4.40	5	0.60
21	7	6	5	7	7	6.40	6	-0.40
22	5	6	6	5	6	5.60	6	0.40
23	5	5	6	6	4	5.20	5	-0.20
25	2	2	2	2	1	1.80	2	0.20
27	1	4	1	2	1	1.80	3	1.20
30	5	6	5	6	6	5.60	6	0.40
31	2	4	1	3	2	2.40	2	-0.40
32	1	1	2	1	1	1.20	1	-0.20
34	7	7	6	7	7	6.80	7	0.20
36	0	1	0	2	1	0.80	1	0.20
39	5	5	5	4	5	4.80	5	0.20
40	7	6	6	6	6	6.20	6	-0.20
41	5	6	4	5	5	5.00	5	0.00
42	4	4	3	6	4	4.20	4	-0.20
45	5	5	6	4	5	5.00	5	0.00
46	4	6	4	5	6	5.00	5	0.00
47	3	4	2	3	4	3.20	3	-0.20
49	1	2	1	2	1	1.40	2	0.60
50	0	0	0	0	0	0.00	0	0.00
53	4	4	6	4	4	4.40	4	-0.40
54	4	6	3	5	4	4.40	4	-0.40
56	6	6	6	6	6	6.00	6	0.00
61	3	3	2	4	3	3.00	3	0.00
65	6	7	5	7	7	6.40	6	-0.40
66	4	7	5	5	7	5.60	6	0.40
67	2	5	2	3	3	3.00	3	0.00
68	7	8	5	7	6	6.60	6	-0.60
69	5	8	4	7	6	6.00	5	-1.00
71	5	7	4	7	5	5.60	5	-0.60
72	5	6	5	6	4	5.20	6	0.80
No	40	40	40	40	40	40	40	40
Avg	4.08	4.74	3.85	4.55	4.23	4.30	4.28	-0.03
Std	2.07	1.85	1.94	1.87	2.02	1.82	1.73	0.44

Rating	Distribution of Average Ratings N	%	Σ%	
0	1	2.50	100.00	
1	1	2.50	97.50	
2	4	10.00	95.00	
3	6	15.00	85.00	
4	1	2.50	70.00	
5	12	30.00	67.50	
6	9	22.50	37.50	<%HA
7	5	12.50	15.00	
8	1	2.50	2.50	
Total	40	100.00		

Rating	Distribution of Session Ratings N	%	Σ%	
0	1	2.50	100.00	
1	2	5.00	97.50	
2	4	10.00	92.50	
3	6	15.00	82.50	
4	6	15.00	67.50	
5	9	22.50	52.50	
6	10	25.00	30.00	<%HA
7	2	5.00	5.00	
8	0	0.00	0.00	
Total	40	100.00		

APPENDIX C

Summary of Post-Experiment Questionnaire Responses

Post-Experiment Questionnaire Responses

Name: ______________________________ *Participant #*__________
Date: 21 May 91 through 23 July 91 *Time* ________

1. *For the entire experiment, as a whole, how would you rate the overall group of all the airplane sounds that you heard? Use the same scale that you used to rate the individual sounds.*

   0=0, 1=2, 2=4, 3=5, 4=10, 5=12, 6=19, 7=8, 8=0 *Overall Rating:* 4.92

2. *Did any of the types of sounds stand out as being particularly less annoying than the others?*

   Yes: 41 *No:* 19

   If yes, which ones? Describe in words :

   Slow=14, Quick=9, Low Pitch=9, Quiet=5, Loud=2, High Pitch=2, Faraway=1, Sharp=1, Other=2, No Aswer=20

   Please describe why you thought that they were less annoying:

   Slow=9, Quiet=8, Low Pitch=7, Less Startling=6, Less Distracting=4, Quick=3, Faraway=1, Not as Sharp=1, Other=2, No Aswer=20

3. *Did any of the types of sounds stand out as being particularly more annoying than the others?*

   Yes: 52 *No:* 8

   If yes, which ones? Describe in words :

   Loud=21, Fast=19, Quick=9, High Pitch=5, Sharp=5, Close/Low Flying=4, Low Pitch=3, Slow=1, Other=9, No Answer=10

   Please describe why you thought that they were more annoying:

   Startled/Scared=17, Loud=13, Close/Low Flying=4, Long=4, Fast=3, High Pitch=3, Physical Discomfort=3, Other=4, No Answer=15

4. *How do you think the sounds affected the tasks that you were doing?*

Check one:	*Not at all:* 4	*Somewhat:* 14
	Minimally: 34	*Considerably:* 8

   Please describe any effects that you experienced during each of the activities:

<u>*Check*</u>		<u>*Effect You Experienced*</u>
______	*Game*	
______	*Television*	SEE
______	*Reading*	TABLE C-1
______	*Puzzle*	

   Were any of the sounds distracting? *Yes:* 48 *No:* 11 No Answer: 11

   Please describe which sounds:

   Loud=22, Fast=14, Slow=6, Low Pitch=2, High Pitch=2, All of Them=3, Whiney=3, Close/Low Flying=2, Sharp=1, Other=6, No Answer=13.

5. *Did you ever lose your place doing any of the activities?* *Yes:* 32 *No:* 26
No Answer: 2

Check		What Happened?
21	*Game*	Distracted/lost concentration=10; forgot whose turn it was=5; other=3
12	*Television*	Distracted/lost concentration=2; could not hear=8; other=1
18	*Reading*	Distracted/lost concentration=5; lost page/place=11; other=1
12	*Puzzle*	Distracted/lost concentration=2; dropped pieces=2; other=4

Please describe which sounds: Loud=18, Quick=10, Slow=5, All=4, Sharp=3
High Pitch=3, Low Pitch=1, Whine=1,
Low Flying=1, Other=2

6. *Please rank order the following qualities of the airplane sounds as to their importance in contributing to your annoyance judgments. Put a number "1" after the quality that annoyed you the most. Put a number "2" after the next most annoying quality. By a process of elimination, put a "3" next to the third most annoying, and so on, until you have ranked all six items, with number "6" being the least annoying. Make sure all blanks are filled in; use each number only once, but use all six numbers.*

Quality	Rank
How long the sound lasts (duration)	3
How strong the peak sound is (intensity)	1
How fast the sound comes on (onset rate)	2
How much whine the sound has (tonality)	4
How low and rumbly the sound is (low frequency)	5
How slow the sound fades away (decay rate)	6

7. *What is your present occupation?* Homemaker=16, Laborer=11, Clerical=9,
Unemployed=7, Student=7, Professional=6,
Sales=4, Retired=3, Other=2

Are there any loud noises in your present occupation? *Yes:* 22 *No:* 36
No Answer: 2

If yes, what kind of noises? Machinery=9, Aircraft=8, Everyday Noises=7,
Loud people/children=4, Radio/Intercoms=2

Were there any loud noises in any previous occupation (including the military)?

Yes: 21 *No:* 34 *No Answer:* 5

 Participant #________

If yes, what was that occupation? Factory Work=7, Teaching=3, Military=3, Laborer=3, Other=6

What were the noises? Machinery/Construction=13, Ships/Aircraft=5, Children=3, Other=2

8. *Have you ever been a pilot?* *Yes:* 0 *No:* 60

   Have you ever worked with or near airplanes? *Yes:* 7 *No:* 52 No Answer: 1

   If yes, in what capacity? Airport Jobs=3, Military Jobs=4

   Did you ever wear hearing protectors against aircraft noise?
   Yes: 3 *No:* 50 No Answer: 7

9. *Have you ever flown in an airplane?* *Yes:* 41 *No:* 19

   If yes, on the average, how often have you flown? Check one:

a *A few times in your life*	15
b. *Once every few years*	12
c. *Once a year*	5
d. *A few times a year*	7
e. *Once a month*	2

10. *Have you ever lived near an airport or near aircraft operations?*
    Yes: 29 *No:* 31

    If yes, have you ever been annoyed by the noise? *Yes:* 14 *No:* 15

    Explain briefly Interrupt Daily Activities=5, Lived Near Airport or Base=4, Low-Flying Planes=3, Other=5.

11. *Have you ever been exposed to unusually high levels of any of the following noises? Check all that apply:*

a *Railroad noise*	22	e. *Truck noise*	20
b. *Traffic noise*	22	f. *Outdoor machinery noise*	21
c. *Industrial noise*	20	g. *Shipboard noise*	1
d. *Aircraft noise*	26		

12. *How would you describe the overall experiment?* Interesting=21, Liked It/Good/Fun=19, OK/Different/Not Bad=9, Well Conducted=9, Boring=3, Noise Does Not Bother Me=2, Sounds Were Realistic=2, Annoying In Some Ways=2, Other=5

Participant #________

13. *How might the experiment be improved?* Alter or Add to the Activities=22, No Improvements=12, More Shade or Not on Patio When Hot=5, Shorten Length of Session/Days=4, Wider Variety of Aircraft Noise=3, Not So Loud=2, Thought It Was Good=2, Have Three Jets Fly By At One Time (More Realistic)=1, Other=6

14. *Do you have any other comments?* No=15, Enjoyed It=9, Professionally Handled=9, Thanks/Would Like To Do It Again=6, Not Representative=2, Hope I Helped You=2, Other=7.

Table C1

Details of Answers to Question 4

Effect You Experienced	Games	Videos	Reading	Puzzles	Totals
Scared/Startled	4	4	7	8	23
Distracted/Loss of Concentration	17	8	19	13	57
Could Not Hear/Loud	5	20	3	1	29
None	3	4	5	7	19
Annoyed/Irritated	2	2	1	1	6
Other	2	2	1	2	7
Total Number of Responses	33	40	36	32	141

APPENDIX D

Analysis of Post-Experiment Questionnaire Responses

D.1 Discussion of Results

The findings from the post-experiment questionnaire support the quantitative results from the present study as well as the questionnaire findings and quantitative results from the laboratory experiments. The following is a discussion of these results.

D.2 Integrated Annoyance Judgments

Three kinds of quantitative annoyance ratings were given by participants in the present experiment. Individual annoyance ratings were given immediately after each recorded overflight sound. At the end of each one-hour session, session ratings were given of the overall annoyance of all the recorded overflight sounds heard during that session. Finally, an experiment annoyance rating covering all sessions was given at the end of the experiment as part of the questionnaire. This experiment annoyance rating related to the overall group of all recorded overflight sounds heard during the entire experiment.

The mean experiment annoyance rating given by the 60 participants in the current study was 4.92. This rating falls between "moderately" and "decidedly" annoying on the annoyance rating scale, as was the case in the laboratory experiments, which had a mean experiment rating of 4.88.

In the present study the mean experiment rating was 0.43 annoyance unit greater than the grand mean of 4.49 for all the session ratings and 0.26 annoyance unit greater than the grand mean of 4.66 for all the individual annoyance ratings. The difference between the mean experiment rating and the mean of the individual annoyance ratings supports the finding in the laboratory experiment of a bias towards somewhat higher annoyance ratings in the questionnaire.

However, since the mean of all the session ratings was 0.17 annoyance unit less than the mean of all the individual ratings, it is no longer safe to make a general assumption that integrated annoyance ratings will generally be higher than the average of individual annoyance ratings. Thus people may integrate annoyance in different ways depending on the amount of time over which they are integrating.

Nevertheless, the general correspondence between the mean experiment, mean session, and mean individual ratings (a difference of only 0.43 annoyance unit at the most) demonstrates, once again, that people are able to integrate individual annoyance ratings to form an overall or epoch-based annoyance rating concerning a number of acoustic events heard during a specified period of time. As was noted in the laboratory experiments, this is an important methodological finding for future proposed studies in the current program of research. Future studies are anticipated where such epoch-based integrated annoyance judgments will serve as the primary dependent variable.

D.3 Factors Affecting Annoyance

As was the case in the laboratory experiment, the majority of the participants found that certain types of sounds were less or more annoying than other types of sounds. About 68 percent of the participants said that there were some types of sounds that stood out as being particularly less annoying than the others. The types of sounds reported to be least annoying were described as "slow" (14 responses). However, "quick" sounds were the next most frequently occurring type (9 responses). "Low-pitched" and "quiet" sounds followed as being the next least annoying types of sounds reported (9 and 5 responses, respectively). The low-pitched sounds may refer to the rumbly B-1B overflight sounds, which had a lower frequency spectrum than that of the other types of MTR aircraft in the sample. Thus frequency spectrum may be a factor in determining the annoyance of MTR sounds, as was indicated in the laboratory experiments.

Participants generally found that the "slow" sounds were less annoying because they were less startling (6 responses). Comments such as "[they] gave more warning of their arrival" and "you were more prepared for the sounds that came on gradually" indicate that it was the lack of a surprise reaction rather than the duration of these sounds that made them less annoying. Nevertheless, duration did seem to be the characteristic that made the short duration sounds less annoying. Comments such as "[the sounds were] over quickly therefore [there was] less distraction from [the] activity" and "[the sounds] did not linger as long" were used to explain why the short duration sounds were less annoying.

Almost 87 percent of the participants reported that certain types of sounds stood out as being particularly more annoying than others. Typical descriptions of the most annoying sounds were the "loud, quick screamers" and the "short, sharp ones". "Loud" sounds were reported most frequently as being the most annoying types of sounds (21 responses) followed by "fast" (19 responses) and "quick" (9 responses). These categories were followed in turn by "high-pitched" (5 responses) and "sharp" (5 responses). Whereas the "sharp" responses likely refer to the same quality as the "fast" responses, the appearance of "high-pitched" in the list points once again toward a possible effect of frequency spectrum. It appears that, as regards MTR sounds, low-pitched overflights may be less annoying and high-pitched overflights may be more annoying, all other factors being equal. A similar indication emerged from the questionnaire responses in the laboratory experiments.

"Fast" and "quick" were considered as separate categories since they were both used in describing the most annoying sounds, while only "quick" was used to describe the least annoying sounds. Moreover, "fast" was used almost twice as often as "quick" when describing the most annoying sounds. This outcome would seem to suggest that participants may have been judging two different sound characteristics when they responded with "fast" versus "quick". When the participants used "fast", they may have been considering the sudden onset of the sound; whereas when they used "quick", they may have been considering the duration of the sound. This hypothesis is supported by the explanations participants gave as to why "fast" versus "quick" sounds were more or less annoying.

Most comments as to why certain sounds were more annoying referred to the startling or frightening quality of the sound (17 responses). For example, "they frightened [me] when they just popped in and popped back out", "they made you jump [be]cause they came out of nowhere", and "they startle you" were the most frequent types of comments. Several comments specifically mentioned loudness (13 responses), physical discomfort in the ears (3 responses), and low-flying or close-flying planes (4 responses) as reasons for annoyance.

Four responses were concerned with sounds of longer duration. Comments seem to indicate that the long sounds were more annoying because they were more distracting or had to be endured for longer. For example, one participant explained " [the] fast [sounds] scare you, the long rumbly [sound] just doesn't ever seem to stop". Another participant explained, "the long, vibrating ones . . . caused more distraction". Yet another participant who mentioned long sounds as being more annoying described a specific instance when he missed part of the dialogue in a video movie because of the sound. This response seems to indicate that in some cases distraction from the activity at hand may be caused by the loudness and duration of the sound as opposed to the startle effect of the sound.

When asked to rank certain sound qualities as to importance in contributing to their annoyance judgments ("1" as most annoying, "6" as least annoying), participants in the current experiment gave the same rankings as participants in the laboratory experiments. Intensity was most frequently ranked as the most annoying quality followed by onset rate, duration, tonality, low frequency, and decay rate, in that order.

Even with less frequent exposures to military overflights, 18 sounds over 8 hours in the current experiment as opposed to 48 to 60 sounds over 2 hours in the laboratory experiments, participants were still able to discriminate between different types of sounds with regard to the qualities that make them more or less annoying.

In addition, these findings support the results of the ANOVAs in which sound level and onset rate proved to account for a large proportion of the variance in participants' ratings, in both experiments. Thus, not only did the participants in the present study and those in the laboratory experiments give identical ordinal rankings to the perceived importance of certain acoustic variables as determinants of annoyance, they also confirmed the general results of the quantitative findings from both experiments.

D.4 Possible Behavioral Effects

Approximately 93 percent of the participants believed that the sounds affected the tasks that they were engaged in during the experiment. Almost all of the effects participants reported experiencing could be classified into the following categories: scared/startled, distracted/lost concentration, could not hear, and annoyed/irritated. A clear pattern of which types of effects occurred for each activity emerged from the responses.

For the video movie activity, 50 percent of the responses fell into the "could not hear" category. For all the other activities (games, puzzles, and reading), most of the responses (between 41 percent and 53 percent) fell in the distracted/lost concentration category.

"Could not hear" was considered as a separate category because of the large number of times it was specifically mentioned. However, it could just as well have been included in the distracted/lost concentration category, since participants momentarily lost focus on the activity. In addition, the second most frequently reported effect during the video movie activity was distracted/lost concentration. Thus distracted/lost concentration seems to be the dominant behavioral effect experienced by participants regardless of activity.

When asked specifically whether any of the sounds were distracting, approximately 81 percent of the participants responded "yes". The sounds most frequently described as distracting were "loud" (22 out of 61 responses) and "fast" (14 out of 61 responses). This finding indicates a high correlation between distraction and annoyance, since respondents reported "loud" and "fast" sounds to be both the most annoying and most distracting types of sounds.

However, it is important to note that only 6 out of the 141 responses concerning effects that the participants experienced during the four activities were classified as annoyed/irritated. Thus, while distraction and annoyance may be highly correlated, the participants tended to experience more distraction or loss of concentration as opposed to annoyance or irritation from recorded MTR overflights.

This is an important finding for future survey methodologies, since it indicates that adverse reactions to MTR noise may be specific to the activity taking place at the time of exposure. It also indicates that respondents may not have particular negative affect or bad feelings toward MTR operations, but may simply resent being distracted or interrupted.

As a concrete instance of possible distraction caused by MTR noise, the present experiment afforded several opportunities to observe possible behavioral interruptions in ongoing activities. Approximately 55 percent of the participants responded "yes" to the question, "Did you ever lose your place during any of the activities?" Concerning what happened when they lost their place, in 19 out of the 54 responses, participants mentioned being distracted or losing one's concentration.

In the case of the games, some participants forgot whose turn it was (5 responses). In the case of reading, many participants lost track of their page or place in the magazine (11 responses). As concerned the puzzle activity, two participants reported dropping puzzle pieces. This latter behavior may be a direct indication of a startle reaction to some of the recorded MTR fsounds. The sounds most frequently described as causing distraction reactions were the "loud" (18 responses), "quick" (10 responses) and "slow" (5 responses) sounds.

D.5 Background of Participants

The present occupations of the participants in the current study were varied although, as mentioned earlier, the most frequently reported occupation was homemaker (16 responses). Other occupations listed were laborer (11), clerical (9), unemployed (7), student (7), professional (6), sales (4), and retired (3). This distribution of occupations was quite similar to the distribution found in the sample of participants for the laboratory experiments: student (12), homemaker (11), professional (10), sales (10), laborer (7), waitress (5) and unemployed (7). There was a somewhat higher percentage of students in the laboratory experiments, however.

In the current sample of participants, 22 out of 58 respondents reported hearing some kind of loud noises in their present occupation. The most frequently reported types of noises heard were machinery (9 responses), aircraft (8 responses), everyday noises from such sources as boats, traffic, lawnmowers, vacuum cleaners (7 responses), loud people/children (4 responses) and radios/ intercoms (2 responses). In the current sample, 21 out of 55 participants responded "yes" when asked whether they heard any loud noises in any previous occupations. These occupations included factory work (7 responses), teaching (3 responses), military (3 responses), and laborer (3 responses). Loud noises heard in these occupations included machinery/construction (13 responses), ship/aircraft (5 responses), and children-related noises (3 responses).

Between 33 percent and 37 percent of the participants reported having been exposed to unusually high levels of noise from the following: railroads, traffic, industrial sources, trucks, and outdoor machinery. Only one person reported having been exposed to unusually high levels of shipboard noise. However, 43 percent of the participants reported being exposed to unusually high levels of aircraft noise.

None of the participants in the present experiment had ever been a pilot. Only seven out of 59 participants reported ever working with or near airplanes. Of those participants who had worked with or near airplanes, three had worked in airport jobs while the other four had worked in military jobs. Three of these participants wore hearing protectors against aircraft noise.

While 41 out of the 60 participants reported having flown on an airplane at least once, only nine participants reported flying more than once a year. In the current sample, 29 participants reported having lived near an airport or near aircraft operations, and 14 of these participants reported having been annoyed by the noise at some time.

Although details of their past noise exposure history may have been different, the responses of participants in both the questionnaire from the current experiment and in the questionnaire from the laboratory experiments indicate an overall similarity in past experience with noise exposure. The only noteworthy difference was in personal experience working with or near airplanes, where the laboratory experiments showed a slightly higher experience factor (14 out of 73 responses).

D.6 Reactions to the Experiment

When asked to describe their reactions to the experiment overall, most of the comments were favorable. Participants frequently commented that they found the experiment interesting (21 responses) and fun (19 responses). Several people felt that the study was well conducted (9 responses). Two people specifically commented on how realistic the sounds were. A few people found the experiment boring (3 responses) and annoying (2 responses). Most of the participants became bored with the activities, especially the ones that were repeated twice each day. By the second day such boredom was even more prevalent. Others mentioned that they were not used to sitting all day and would have liked to have moved around more.

Comments on how the experiment could be improved generally concerned altering or adding to the activities (22 responses). A few participants mentioned shortening the length of the sessions or days (4 responses) and either providing more shade or not having activities on the porch when it was hot (5 responses). As far as the recorded MTR sounds were concerned, a few participants suggested having a wider variety of aircraft sounds (3 responses). One participant suggested that having three jets fly by at one time would be more realistic. Two participants thought the noises should not be so loud. Several participants felt that no improvements were necessary (12 responses) or that the experiment was good as conducted (2 responses).

Although the details may have been different, the overall reactions of the participants to the present experiment were quite similar to those obtained in the laboratory experiments. In general the reaction in both cases was positive, with a few negative responses and several constructive suggestions for improvement.

D.7 Summary

In summary, the Post-Experiment Questionnaire in the present study, like the almost identical questionnaire employed in the laboratory experiments, yielded results that were in general agreement with the quantitative findings of both experiments. MTR overflight sounds with higher intensities and faster onsets tend to be more annoying. This uniformity of results attests to the similarity of the two samples of participants and their reactions to MTR aircraft sounds. Taken together the questionnaire results revealed some of the possible mechanics of integrated annoyance judgments, some of the perceived factors underlying individual annoyance reactions and some of the behavioral responses that might be expected to MTR overflight sounds.

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